Risk price decomposition and the output gap

Ryuta Sakemoto[1]

2 May 2024

Abstract

We employ a time-varying price of risk model that allows us to track the change in prices of risk. We find that the output gap generates the time-varying prices of market and momentum risks, but the exposures to the output gap have the opposite signs. In contrast, we do not observe that the output gap is linked to time variations in the prices of value and investment risks. We uncover that the output gaps impact the prices of market risk for European and Japanese portfolios, while there are weak relationships between the prices of momentum risk and output gaps.

Keywords: Time-varying model, Business cycles, Output gap, Risk factors, Momentum factor
JEL codes: G10, G12

---

[1] Faculty of Economics and Business, Hokkaido University. Full Address: Nishi 7 Kita-Jo9 Kita-ku Sapporo-shi Hokkaido, 060-0809, Japan. Telephone: +81-11-706-3189. Email: rsakemoto @econ.hokudai.ac.jp. Funding: This work was supported by Japan Society for the Promotion of Science KAKENHI Grant Number 20K22092 and 22K13430.
Acknowledgments: I am grateful to Kenneth French, Sydney Ludvigson, and Lu Zhang for sharing their data. I gratefully acknowledge Takao Asano, Joseph P. Byrne, Xiaojing Cai, Hui Chen, Shingo Goto, Tokuo Iwaisako, Akitada Kasahara and conference participants at the Hokkaido University, Nippon Finance Association, Kanazawa Seiryo University, Osaka University for helpful comments. Any remaining errors are my responsibility alone.

1. Introduction

Stock prices and the future cash flows of firms are linked to business cycles. Many studies have explored whether macroeconomic variables affect market risk premiums.[2] In contrast to studies that seek to uncover a nexus between financial variables and market risk premiums, models based on macroeconomic variables provide explanations for why expected returns vary over business cycles (Cochrane, 1996). Among the many macroeconomic variables, we focus on the output gap, which is a key variable in capturing business cycles. Cooper and Priestley (2009) point out that the output gap is based on production-related data and contains information that is different from consumption data.[3] The weak point of consumption data is that they do not show much variation, and therefore do not comove with business cycles (Cochrane, 1996; 2021). The output gap is linked to market premiums in a time-series context (Cooper and Priestley, 2009), and we extend these findings and explore how the output gap creates time-varying risk premiums in cross-sectional asset pricing models.[4] To this end, we employ Adrian et

---

[2] See for example, Chen et al. (1986), Griffin et al. (2003), Ludvigson and Ng (2007), Liu and Zhang (2008) and Cooper and Priestley (2011).

[3] Campbell and Cochrane (1999), Yogo (2006) and Campbell et al. (2020) employ consumption-based models. Atanasov et al. (2020) investigate a relationship between consumption growth and the market risk premium in a time-series context.

[4] Colacito et al. (2020) adopt the output gap and focus on the currency risk premium.

al.'s (2015) approach and investigate how the output gap drives time-varying prices of risk. This approach offers several advantages: we do not estimate time-varying risk prices using a rolling-window approach, which focuses on a relatively short period. Focusing on a short period tends to miss a rare event that impacts prices of risk (e.g., Schularick and Taylor, 2012). Moreover, Adrian et al.'s (2015) approach does not employ the scaling factors, and therefore, the interpretation of time-varying prices of risk is more straightforward.[5] Normally, risk price coefficients in conditional factor models do not represent risk prices, as in Lettau and Ludvigson (2001a), while Adrian et al.'s (2015) approach directly provides risk prices. This aspect benefits investors who adjust their investment strategies based on business cycles.

It is a well-known fact that the basic capital asset pricing model (CAPM) proposed by Sharpe (1964) and Lintner (1965) fails to account for cross-sectional stock portfolio anomalies. Multifactor models, which have both market and additional factors are partially successful in explaining cross-sectional stock portfolio anomalies (e.g., Fama and French, 1992, 1993, 2015; Carhart, 1997; Hou et al., 2015). Risk premiums, however,

[5] Jagannathan and Wang (1996), Cochrane (1996), and Lettau and Ludvigson (2001a) employ scaling factors, while Lewellen and Nagel (2006) and Hollstein et al. (2020) do not adopt state variables in order to avoid misspecifications.

may not be constant and may vary over business cycles. To capture these time-varying risk premiums, several studies have proposed conditional factor models.[6] They allow betas to reflect changes in economic states, while many models in the previous studies do not focus on tracking continuous changes in risk premiums. Ferson and Harvey (1991) and Adrian et al. (2015) are exceptions, because they present that continuous changes in risk premiums create smaller pricing errors in cross-sectional asset pricing models.[7]

The first contribution of this study is that we employ a time-varying prices of risk model that allows us to track how the output gap is associated with risk prices. To this end, we adopt a generalised Fama and MacBeth (1973) and Ferson and Harvey (1991) approach proposed by Adrian et al. (2015). This approach decomposes risk premiums into betas, prices of risk, and state variables, and presents whether state variables generate time-varying prices of risk.[8] This approach allows us to track how prices of risk vary

---

[6] Jagannathan and Wang (1996), Cochrane (1996), Ferson and Harvey (1999), Lettau and Ludvigson (2001a), Lewellen and Nagel (2006), and Hollstein et al. (2020).

[7] Byrne et al. (2017) and Byrne et al. (2022) investigate continuous changes in risk premiums on the currency portfolios.

[8] Some studies consider prices of risk as risk premiums, see, for example, Ferson (2019). We distinguish prices of risk from risk premiums in this study and our definition of risk premiums follows that of Cooper and Priestley (2009). A change in prices of risk leads to a change in risk premiums.

over time. Our study is related to Vassalou (2003), who tests whether future GDP growth explains cross-sectional stock portfolios. Our study is also linked to the work of Cooper et al. (2022), who reveal that macroeconomic variables impact value and momentum anomalies. However, our research differs from these previous studies since they do not illustrate how the prices of risk vary over time.

Our second contribution is that we explore how a change in the output gap affects the risk prices on other risk factors. For instance, a value premium is associated with business cycles. Zhang (2005) and Bai et al. (2019) propose theoretical models that account for the relationship. In their models, value firms are burdened with more unproductive real capital than growth firms and are riskier during recessions, and this risk results in the value premium. The value premium is consistent with the negative investment-expected return relationship, since given an expected cash flow, an increase in investment leads to lower expected returns (e.g., Hou et al, 2015). A momentum premium is also linked to macroeconomic states. Johnson (2002), Liu and Zhang (2008) uncover that past winner firms and loser firms tend to have heterogeneous exposures to expected growth that is influenced by business cycles. Moreover, Liu and Zhang (2014) construct an investment-based model that shows higher expected growth and higher expected returns. Li (2018) proposes a theoretical model that explains the value and momentum premiums simultaneously. These studies highlight that risk prices are tied to business cycles captured by the output gap. Motivated by these studies, we extend the work of Adrian et al. (2015) and employ the four-factor model (Fama and French, 1993; Carhart, 1997), the five-factor model (Fama and French, 2015) and the q-factor model (Hou et al., 2015) and explore whether the output gap impacts the time variations of the risk prices.

The third contribution of this study is that we explore the relationships between the output gap and risk prices not only in the U.S. but also in European and Japanese markets. Factor risk premiums differ between the U.S. and other regions. For instance, Fama and French (2012) and Karolyi and Wu (2018) report weak value factor premiums in North America. Additionally, Fama and French (2017) demonstrate that profitability and investment factor premiums are weak in Japan. The degree of declines in market anomalies after publication differs between the U.S. and other stock markets (MacLean and Pontiff, 2016; Jacobs and Muller, 2020). These empirical results pose the question of whether the time-series findings reported by Cooper and Priestley (2009) hold in our conditional factor model.

To preview our results, we find that the output gap generates the time-varying prices of market and momentum risks for the U.S. portfolios. The output gap is negatively related to the price of market risk but positively linked to the price of momentum risk. Additionally, we obtain average prices of market and momentum risks using average values of state variables. The estimated average prices of market and momentum risks are both positive. These results are associated with the findings of Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016), who report that average market and momentum factor premiums are positive but have different exposures to business cycles. Our results also indicate that the momentum risk price is more sensitive to a change in the output gap compared with the market risk price. The negative relationship between the output gap and the market risk premium is consistent with Cooper and Priestley (2009), but our important deviation is that we consider time variations of cross-sectional asset pricing models. The positive relationship between the output gap and the momentum risk price is supported by the theoretical models that assume heterogeneous firms against business cycle shocks (Johnson, 2002; Liu and Zhang, 2014; Li, 2018). Liu and Zhang (2008) demonstrate that momentum profits stem from the fact that past winner firms have high expected growth. A recession reduces expected growth for the past winner firms, resulting in lower momentum profits. Sagi and Seasholes (2007) describe that past winner firms contain growth options, and their assets values increase during expansions. These large asset value fluctuations are riskier, and their expected returns are high.

We also observe that the output gap does not have an impact on time variations of value and investment risk prices. Our results do not indicate that the risk prices on value and investment are zero, since the average risk prices on these risks carry positive values. Our results highlight that changes in value and investment risk prices are not sensitive to a change in the output gap.

We confirm that the output gap is the main driving force for a change in the market risk price after controlling for other variables including the economic uncertainty index (Jurado et al., 2015). Bali et al. (2017) report that uncertainty averse investors require compensation for holding negative economic uncertainty beta stocks. We note that economic uncertainty is rather associated with the size risk price. This stems from the growth opportunities of small firms, since they are more sensitive to changes in economic uncertainty (Carlson et al., 2004; Garleanu et al., 2012). Economic uncertainty is associated with business cycles (Bekaert and Engstrom, 2010; Adra and Menassa, 2023) and the output gap captures them. Therefore, economic uncertainty does not add incremental information for the market risk price.

Moreover, we observe that there are some heterogeneities across regions. The output gaps are negatively associated with the market risk prices in Europe and Japan, but they do not impact the time variations on the momentum risk prices. This is in line with the finding of Fama and French (2012) who report that the momentum anomaly in Japan is weak. The weak results in Europe are due to the fact that business cycles are not completely synchronised across these countries (Kose et al., 2012). Each macroeconomic data series entails measurement errors and may have caused the weak results (Ludvigson and Ng, 2007). In addition, the value risk prices are sensitive to change in the output gap in Japan.

The rest of the paper is organised as follows: Section 2 describes econometric methodologies, Section 3 explains the data sets, Section 4 presents the main empirical results, Section 5 conducts robustness tests and Section 6 provides the conclusion.

2. Econometrics model

This section describes an estimation method for time-varying risk prices. Following Ferson and Harvey (1991) and Adrian et al. (2015), the excess return of portfolio *i*, $R_{i,t+1}$ is decomposed into $a_i + c_i' S_t$, the factor exposure multiplied by risk factor innovations $\beta_i' u_{F,t+1}$ and an error term $\varepsilon_{i,t+1}$:

$$R_{i,t+1} = a_i + c_i' S_t + \beta_i' u_{F,t+1} + \varepsilon_{i,t+1} \qquad (1)$$

where S_t is a $k_1 \times 1$ vector of lagged state variables and $u_{F,t+1}$ is a $k_2 \times 1$ vector of risk factor innovations will be described later in this paper, and a_i, c_i and β_i are estimated parameters.[9] This model includes k_1 state variables including the output gap. In the later analysis, we add other state variables and assess whether the output gap entails different information from other state variables. Adrian et al. (2015) also propose a model that includes time-varying betas, while we do not use that model. Ferson and Harvey (1991), Adrian et al. (2015), and Byrne et al. (2022) uncover that main driving forces that generate smaller pricing errors are time-varying prices of risk. In addition, Adrian et al. (2015) assume asymmetric assumption between changes in betas and those in prices of risk and it causes difficulty in interpretation.[10]

Adrian et al. (2015) adopt the methodology in Campbell (1996) who propose that risk factor innovations capture changes in investment opportunity sets and price cross-sectional portfolios. The innovation components are obtained by the following vector autoregressive (VAR) process:

$$X_{t+1} = \mu + \Phi X_t + u_{t+1} \tag{2}$$

where X_t is a $(k_2 + k_1) \times 1$ vector that entails a $k_2 \times 1$ vector of risk factors and a

---

[9] The sum of terms $a_i + c_i'$ can be written as the factor exposure multiplied by the risk price using no-arbitrage conditions, see Equation (4).

[10] We present empirical evidence that time-varying betas do not play an important role in reducing pricing errors in Table 8.

$k_1 \times 1$ vector of state variables, μ and Φ are estimated parameters of the VAR, and an error vector u_{t+1} is written as

$$u_{t+1} = \begin{bmatrix} u_{F,t+1} \\ u_{S,t+1} \end{bmatrix} \tag{3}$$

where $u_{F,t+1}$ indicates an error term of risk factors and $u_{S,t+1}$ does that of state variables.

Adrian et al. (2015) impose no-arbitrage restrictions on Equation (1) and they allow us to reduce the number of parameters, which leads to smaller pricing errors in terms of cross-sectional asset pricing. Equation (1) is rewritten with the no-arbitrage restrictions as

$$R_{i,t+1} = \beta_i'\lambda_0 + \beta_i'\Lambda_1 S_t + \beta_i' u_{F,t+1} + \varepsilon_{i,t+1} \tag{4}$$

where λ_0 is a $k_2 \times 1$ vector of the prices of risk, Λ_1 is a $k_2 \times k_1$ matrix of the prices of risk, and $\Lambda_1 S_t$ indicates the time-varying prices of risk. For instance, the time-varying market price of risk generated by the output gap is written: $\Lambda_{1,mkt} S_{gap,t}$. The average prices of risk $\bar{\lambda}$ are denoted as

$$\bar{\lambda} = \lambda_0 + \Lambda_1 E[S_t]. \tag{5}$$

We provide the details of estimation steps in Online Appendix.

3. Data

3.1. *Output gap*

Following Cooper and Priestley (2009), we use the monthly industrial production (IP) index as the output. In contrast to GDP, these data are obtained at a monthly frequency from the Organisation for Economic Co-operation and Development (OECD). Our research aim is to investigate relationships between the output gap and cross-sectional portfolio return differences, and we employ revision data.[11] We consider the output gap as the deviation of the logarithm IP (ip) from linear and quadratic trends (Clarida et al., 2000; Fuhrer and Rudebusch, 2004; Cooper and Priestley, 2009). The output gap captures business cycles using production-based data that entail different information from consumption-based data and demonstrates more fluctuation. These characteristics are desirable in an asset-pricing context (Cochrane, 1996; 2021).[12] The output gap (*GAP*) is obtained as an error term e_t of the following regression:

$$ip_t = a + b \cdot t + b \cdot t^2 + e_t \tag{6}$$

where a, b and c are estimated parameters. Following Cooper and Priestley (2009), we

[11] We also adopt original release data of the industrial production and find the similar results in Table A34 of Online Appendix.

[12] Industrial production growth is also production-based data whereas it is not successful in predicting stock market returns (e.g., Pesaran and Timmermann, 1995).

employ in-sample estimations in our analysis. It is because the aim of this study is to propose cross-sectional asset pricing models, not to conduct out-of-sample tests.

When we calculate the output gap for European countries, we run Equation (6) for each country and the output gap for European countries is provided by the real GDP weighted average, which is the standard in the literature (e.g., Kilian and Zhou, 2018; Cooper et al., 2022). We employ the output gap as the main state variable in Equation (6). Figure 1 displays the output gaps for the U.S., European countries and Japan. The output gap for the U.S. falls before and during recessions. The results of Cooper and Priestley (2009) end before the global financial crisis (GFC) and the COVID-19 pandemic, and we observe that the output gaps fall significantly during the two crises. Three output gaps comove while there are some heterogeneities. For instance, the output gap for Japan rises around 1990 and falls around 2000, which reflects the bubbles and bursts of the financial and real estate markets. Martin and Ventura (2012) propose a potential channel that bubbles cause transfer of resources from inefficient investors to consumers and efficient investors, which leads to an increase in the real output.

3.2. *Other state variables*

To investigate whether the output gap has distinct information from other macroeconomic variables that affect business cycles, we include the following state variables: term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Chen et al. (1986) and Cooper et al. (2022) presented that *TERM*, *UI*, and *DEI* priced cross-sectional portfolios. We employ them as state variables because our aim is to explore whether the output gap works as a driving force of time-varying prices of risk.[13]

$TERM_t$ for the U.S. is calculated as the spread between the 10-year government bond yield LGB_t and the short-term rate rf_t. We adopt the one-month Treasury-bill rate for the U.S. and the three-month interest rates for Europe and Japan as rf_t, due to data availability. The data are obtained from the Federal Reserve Bank of St. Louis and the OECD.

UI_t is defined as the difference between the inflation rate I_t and the expected inflation $E[I_t|t-1]$ as

$$UI_t \equiv I_t - E[I_t|t-1] \tag{7}$$

where I_t is the change in the logarithm of the seasonally adjusted consumer price index (cpi_t) and denoted as $I_t = cpi_t - cpi_{t-1}$. The expected inflation $E[I_t|t-1]$ is given as the difference between rf_t and the expected real short-term rate $E[RHO_t|t-1]$:

[13] Our estimation framework proposed by Adrian et al. (2015) allows us to include the same variables as risk factors and state variables.

$$E[I_t|t-1] = rf_t - E[RHO_t|t-1] \tag{8}$$

where $RHO_t \equiv rf_t - I_t$ and a change in RHO from $t-1$ to t is modelled as a moving average (MA) process: $RHO_t - RHO_{t-1} = u_t + \theta u_{t-1}$. Following Chen et al. (1986) and Cooper et al. (2022), we estimate the MA process and obtain $E[RHO_t|t-1]$ as the difference between RHO_{t-1} and $\hat{u}_t + \theta\hat{u}_{t-1}$:

$$E[RHO_t|t-1] = RHO_{t-1} - (\hat{u}_t + \theta\hat{u}_{t-1}). \tag{9}$$

The seasonally adjusted consumer price index is downloaded from the OECD, and all variables for the European countries are given by the real GDP weighted averages (e.g., Kilian and Zhou, 2018; Cooper et al., 2022). We do not include the consumption-to-wealth ratio (Lettau and Ludvigson, 2001b) and the cyclical consumption (Atanasov et al., 2020). It is because the consumption-to-wealth ratio is available only at a quarterly frequency. This study focuses on a production-based asset pricing model and does not include the cyclical consumption. Cochrane (2021) also highlights that the production-based asset pricing model is directly linked to business cycles compared with the consumption-based asset pricing model.

3.3. *Portfolios*

We employ 25 U.S. portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom).[14] We test these four types of test portfolios because Liu and Zhang (2008) and Lewellen et al. (2010) show that risk price estimates are sensitive to a portfolio sorting rule. Moreover, we employ combined four types of test portfolios and 30 industry portfolios to mitigate the effects of the factor structure (Lewellen et al., 2010) in Online Appendix. The one-month U.S. Treasury-bill yield is used as the risk-free rate. These data extend from October 1963 to July 2020.

Following Fama and French (2012, 2017), we investigate European and Japanese portfolios. Although European countries are not completely integrated, Fama and French (2012, 2017) address that adopting European portfolios allows us to diversify test portfolios, which leads to improvement of regression fits.[15] We have four datasets, with each dataset including 25 portfolios sorted by Size-B/M, Size-OP, Size-Inv and Size-Mom. These data cover from November 1990 to July 2020, and all returns are calculated using U.S. dollars. The data sets are downloaded from Kenneth French's website, and we

[14] In Online Appendix, we employ 25 U.S. portfolios sorted by operating profitability and investment (Table A35) and 30 US industry portfolios as test assets (Table A33).

[15] Fama and French (2012; 2017) also propose to use Asia Pacific portfolios, but we do not employ them due to data availability for monthly industrial production indices.

calculate the excess returns by subtracting the risk-free rate.

3.4. *Risk Factors*

We investigate the standard CAPM (Sharpe, 1964; Lintner, 1965), the four-factor model (Fama and French, 1992, 1993; Carhart, 1997), the five-factor model (Fama and French, 2015) and the *q*-factor model (Hou et al., 2015).[16]

We employ the value-weighted index of the Center for Research in Security Prices (CRSP) as the market portfolio and the excess return of the index is used as the market factor (*MKT*). In addition to *MKT*, we employ size (*SMB*), value (*HML*) and momentum (*UMD*) factors for the four-factor model. The five-factor model include *MKT*, *SMB*, *HML*, profitability (*RMW*) and investment (*CMA*). These factors are obtained from Kenneth French's website. The *q*-factor model consists of *MKT*, size (*R_ME*), investment (*R_IV*) and profitability (*R_ROE*). We focus on the U.S. for the *q*-factor model due to data availability, and the data are downloaded from Lu Zhang's website.

4. Empirical results

[16] Tables A39-41 adopt q^5 (Hou, et al., 2021) and six-factor (Fama and French, 2018) models and find a similar pattern.

4.1. *CAPM result in the U.S.*

We begin with the CAPM. The risk factor is *MKT* and the state variable is the U.S. output gap (*GAP*). We begin with the simplest model to assess the relationship between *MKT* and *GAP*. Table1 presents the estimates of price of risk parameters using Equation (4), and the heteroskedasticity robust standard errors proposed by Adrian et al. (2015) are reported in parentheses. Row (a) displays the results for 25 Size-B/M portfolios. We find that *GAP* is negatively related to the price of *MKT* risk, and the estimate is statistically significant at the 1% level. The negative relationship is in line with Cooper and Priestley (2009) who focus on the time-series relationship. Our result suggests that the price of market risk is higher during economic contractions, as reported by Ferson and Harvey (1991), DeStefano (2004), and Adrian et al. (2015). When *GAP* goes up by one standard deviation, the price of *MKT* risk is lower by 0.53% per month ($-8.11 \times 0.065 = 0.53$).

The average price of risk $\bar{\lambda}$ obtained by Equation (5) in row (a) of Table 1 is 0.64% per month and statistically significant at the 10% level, which suggests that the price of *MKT* risk varies over time and the average price is positive. Importantly, our main finding that *GAP* as a strong driving force in generating the time variation on *MKT* is robust across test portfolios, as shown by rows (b), (c) and (d).

Moreover, we follow Burnside (2011) and calculate a R^2 statistic as

$$R^2 = 1 - \frac{(\bar{R}-\widehat{ER})'(\bar{R}-\widehat{ER})}{(\bar{R}-\ddot{R})'(\bar{R}-\ddot{R})} \tag{10}$$

where $\bar{R}$ is an $N \times 1$ vector of mean returns for individual test portfolios, $\widehat{ER}$ is an $N \times 1$ vector of mean returns predicted by the model in Equation (4), and $\ddot{R}$ is an $N \times 1$ vector of cross-sectional average of the mean returns for individual test portfolios, indicating that all elements of $\ddot{R}$ has the same value. We find that R^2s in Table 1 are negative for all results suggesting that *MKT* does not explain cross-sectional return differences across test portfolios. These negative values of R^2s are also observed by Burnside (2011) when factor models do not explain cross-sectional return differences.

4.2. *Four-factor model in the U.S.*

Next, we consider the four-factor model. Fama and French (1992, 1993) and Carhart (1997) find that the four-factor model that includes *MKT*, *SMB*, *HML* and *UMD* capture cross-sectional returns across stock portfolios better than the CAPM. To explore whether the output gap plays an important role in generating time-varying prices of risk, we control for effects of *TERM*, *UI*, and *DEI,* which are linked to business cycles (Chen et al., 1986; Cooper and Priestley, 2011; Cooper et al., 2022).

Table 2 displays the parameter estimates for the four-factor model, and we observe that the strong negative relationship between *MKT* and *GAP* is robust after controlling for the other variables from rows (a) to (d). *DEI* is also negatively linked to *MKT*, which presents that a rise in expected inflation reduces the price of market risk (Chen et al., 1986; Cooper et al., 2022). R^2s increase from those of the CAPM and range from 0.52 to 0.86, indicating that the four-factor model explains cross-sectional return differences better than the CAPM. Including *GAP* and *DEI*, we see that the constant term becomes insignificant or marginally statistically significant. Panel A in Figure 2 depicts the estimated price of market risk with 95% confidence intervals, which is calculated as $\Lambda_{1,mkt}S_{gap,t}$. We observe that the price of risk varies over time and rises after economic downturns, such as the collapse of the dot-com bubble and the GFC. The average price of risk is above zero, which is consistent with the results in Table 2. An increase in the price of market risk after the GFC was driven by the expansionary monetary policy (e.g., Bernanke, 2020). It is because the loose monetary policy mitigated financial constraints for banks and encouraged risk-taking, resulting in an increase in asset pricings (Bruno and Shin, 2015; Miranda-Agrippino and Rey, 2020). This explains why the fluctuation of the price of market risk was relatively stable when the stock market plunged during the GFC. In contrast, the price of market risk jumped during the COVID-19 pandemic. This is related to the fact that the recession triggered by the pandemic differs from other recessions (Donthu and Gustafsson, 2020; Sakemoto, 2023). For instance, the pandemic lockdown forced some firms to stop economic activities, leading to a significant drop in the output gap, as demonstrated by Figure 1. Moreover, the GFC had negative impacts on most stock prices, whereas some sectors benefited from the pandemic.

Moreover, the time-varying price of *UMD* risk is positively associated with *GAP*, except for the Size-Inv test portfolios. This result is in line with Chordia and Shivakumar (2002) and contrasts with Griffin et al. (2003). Johnson (2002) and Liu and Zhang (2008) highlight that momentum profits stem from heterogeneous expected growth across firms. Sagi and Seasholes (2007) report that high past winner firms carry high growth options. Their asset values increase during expansions, leading to large fluctuations in asset values. Therefore, these firms are riskier and entail higher expected returns. Li (2018) indicates that momentum profits come from high exposures to price shocks of investment goods. Our results support these views since the output gap affects the firm's expected growth and investment values. We find that the average price of *UMD* risk is too large, except for the Size-MOM test portfolios. This is associated with that the momentum risk is sensitive to a change in the output gap. The absolute value of the price of *UMD* risk parameter is 22.9, but that on *MKT* is 7.3, which suggests that the time-varying price of *UMD* risk has larger fluctuations than that on *MKT*.

Panel B of Figure 2 shows the time-varying price of *UMD* risk, which is calculated as $\Lambda_{1,umd}S_{gap,t}$. We see that the price of risk also varies over time, while the fluctuation differs from that of the price of market risk. This stems from *UMD* being positively related to *GAP*, whereas *MKT* is negatively linked to it. Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) report that *UMD* has a negative exposure to *MKT*, but we can see that both average prices of risk are positive. The heterogeneous time variations of *MKT* and *UMD* and different driving forces lead to these results. The expansionary monetary policy led to a decline in the price of *UMD* risk and it became insignificant in most periods after the GFC. We also find that the price of *UMD* risk was generally higher before the GFC. This may be related to the fact that the GFC reduced long-term economic growth, which led to a decline in expected growth for past winner firms.[17] Another point worth mentioning is that we do not observe clear evidence that prices of *SMB* and *HML* risks vary over time, since the estimated price of risk parameters do not show a consistent pattern across the four results.

Overall, we find that *GAP* generates the time-varying prices of *MKT* and *UMD* risks, and an economic contraction causes an increase in the price of market risk and a decrease in the price of momentum risk.

---

[17] For instance, Fatás and Summers (2018) point out that the self-defeating fiscal consolidations are key elements in the decline in economic growth after the GFC.

4.3. *Five-factor model in the U.S.*

Given the significant relationship between *GAP* and *MKT* in the four-factor model, we explore other risk factors. We employ the five-factor model proposed by Fama and French (2015). In addition to *MKT*, *SMB* and *HML*, we adopt *RMW* and *CMA* factors and control for the same three state variables that affect business cycles.

Table 3 demonstrates the same pattern: *GAP* and *DEI* are negatively linked to the price of *MKT* risk. In contrast, we do not see the prices of *SMB*, *HML*, *RMW* and *CMA* risks are influenced by the macro economic conditions. Fama and French (2015) and Hou (2015) report that high profitability is related to high expected returns. This is because if the ratio between expected profitability and investment is high, this firm should entail high discount rates. It would be expected that *GAP* is positively related to *RMW*, but we do not observe this pattern. This stems from the fact that the output gap affects profitability and investments simultaneously.

4.4. *q-factor model in the U.S.*

Furthermore, we employ the *q*-factor model proposed by Hou et al. (2015). The *q*-factor model includes *MKT*, *R_ME*, *R_IV* and *R_ROE* and outperforms the four-factor model in explaining momentum and profitability anomalies (Cooper and Maio, 2019). Table 4 shows that *GAP* and *DEI* are still statistically significant for the price of *MKT* risk after controlling for the other three factors, which is consistent with the results in Tables 2 and 3. We observe that *TERM* impacts on the prices of *R_ME* and *R_ROE* risks. An increase in the term spread leads to an increase in these prices of risk. The profitability factor indicates that high profitability firms carry higher expected returns (Hou et al., 2015). The steep term spread predicts economic expansions, which induces the higher profitability of firms and higher expected returns (Estrella and Hardouvelis, 1991).

In summary, we confirm that our previous finding is robust and that *TERM* is a main driving force in generating the time-varying price of *R_ME* and *R_ROE* risks.

4.5. *RMSPE in the U.S.*

We explore whether the time-varying price of risk model reduces pricing errors. Figure 3 provides a visual impression of how the time-varying model works. The vertical axis indicates the predicted excess returns calculated by the time-varying model, and we employ the four-factor model as an example. The horizontal axis shows the realised excess returns. We note that most portfolios are close to the 45-degree line, which represents that the model is successful in creating smaller pricing errors. Importantly, our results are robust across test portfolios.

Moreover, we follow Adrian et al. (2015) and calculate root mean squared pricing errors (RMSPE) for the time-varying model and a benchmark model. We adopt the Fama and MacBeth (1973) approach for the benchmark model. Table 5 reports RMSPE relative to the benchmark. If the displayed value is smaller than one, then it means that the time-varying risk model is successful in reducing RMSPE. We observe that all three models generate smaller RMSPE, and these are robust across test portfolios.

4.6. *Four factor model in Europe and Japan*

Having found the importance of the output gap for the price of market risk in the U.S., we investigate other countries. We focus on European and Japanese portfolios, since international stock markets are partially segmented, and consequently, these regions should be explored separately (Fama and French, 2012; Karolyi and Wu, 2018).[18] We employ the four-factor model and the four state variables used in Table 2. The state variables for European countries are weighted by real GDP data, as proposed by Kilian and Zhou (2018) and Cooper et al. (2022).

Table 6 demonstrates that *GAP* is negatively linked to the price of *MKT* risk for

[18] Fama and French (2012) include Asia-Pacific portfolios while it is difficult to calculate output gaps in this region due to data availability.

all test portfolios, which is consistent with the results in the U.S. When we focus on row (a), an increase in the one standard deviation of *GAP* causes a decline in the price of *MKT* risk by 0.66% per month ($-1.84 \times 0.36 = 0.66$). This magnitude is not so different from that of the U.S. In contrast, *DEI* does not have an impact on the time variation of the price of *MKT* risk because inflation rates are more heterogeneous across European countries. The relationship between *GAP* and the price of *UMD* risk is not clear for the European stocks, which may indicate that the time-varying price of *UMD* risk is a U.S.-specific result. We also find that the term spread is positively associated with the price of *SMB* risk for all results. Figure A2 and Table A10 show that the time-varying price of risk model reduces pricing errors.

Next, we repeat the same estimation for Japanese portfolios. Table 7 displays that a negative *GAP* leads to an increase in the price of *MKT* risk, which are observed in the U.S. and European results. An increase in the one standard deviation of *GAP* reduces the price of *MKT* risk by 0.65% per month ($-9.56 \times 0.068 = 0.65$) for the Size-B/M portfolios, which is a similar magnitude to the other regions. The average price of *MKT* risk is insignificant for all four results, which contrasts with the results in the other regions. Panel B of Figure A1 displays the time-varying price of *MKT* risk and confirms that the confidence intervals include both positive and negative areas for most periods. This is in line with Fama and French (2012) who report that the return on *MKT* is negative in Japan.

Interestingly, *GAP* is negatively associated with the price of *SMB* risk and positively associated with that on *HML*, which is not observed in the other two regions. Fama and French (2017) address that there is a strong value anomaly in Japanese stocks, while we see that the average price of *HML* risk is not statistically significant for all four results. The parameter estimates indicate that the price of *HML* risk is sensitive to a change in *GAP*, except for the Size-B/M portfolios. For instance, an increase in the one standard deviation of *GAP* causes an increase in the price of *HML* risk by 1.15% per month for the Size-OP portfolios ($16.86 \times 0.068 = 1.15$). This implies that the strong value anomaly depends on economic states. In contrast, *GAP* does not affect the price of *UMD* risk. This pattern is similar to the European results and contrasts with the U.S. results. We also confirm that the time-varying price of risk model for Japan creates smaller pricing errors than the benchmark model, as reported by Figure A3 and Table A11.

Overall, we confirm that *GAP* is a driving force for the time-varying price of *MKT* risk for European and Japanese stock portfolios, which is consistent with the results in the U.S.[19]

---

[19] We also observe the strong relationships between the output gap and *MKT* for European and

5. **Further analysis**

This section contains the results of the following further investigations: (i) different state variables in the U.S. and (ii) assessing effects of adding risk factors and time variation. Moreover, Online Appendix includes: (iii) different state variables in Europe and Japan, (iv) comparison with rolling regressions, (v) increasing the number of test portfolios, (vi) different model for the output gap estimation, and (vii) effects of time lags.

5.1. *Different state variables in the U.S.*

Having found the importance of the output gap, we employ different state variables with it. Instead inflation variables such as *UI* and *DEI*, we use a short-term interest rate (*SHO*) that predicts stock returns (e.g., Breen et al., 1989; Ang and Bekaert, 2007). We deploy the one-month Treasury-bill rate of the U.S. and the three-month interest rates for Europe and Japan as *SHO*s.

We include an uncertainty measure, since an expected stock return depends on investment opportunities, and an increase in economic uncertainty leads to a decline in output and consumption and a higher price of risk (e.g., Bansal et al., 2014). We employ

Japanese five-factor models, as shown by Tables A8 and A9.

the economic uncertainty index (*UNC*) proposed by Jurado et al. (2015). Bali et al. (2017) adopt this index and present empirical evidence that an investor requires compensation for negative economic uncertainty betas. *UNC* captures uncertainty as errors of prediction models that adopt factors extracted from macroeconomic and financial indicators. We use the index based on the one-month-ahead prediction errors, and the data is obtained from Sydney Ludvigson's website. This index is based on the U.S., while the U.S. stock market impacts other stock markets in advanced economies (e.g., Rapach et al., 2013); thus, we use it for all regions. Cooper et al. (2022) also propose adopting a financial market index in the U.S. for advanced economies' markets.

We repeat the estimation of Table 2 but with the following four state variables: *GAP*, *TERM*, *SHO* and *UNC*.[20] We keep *TERM* since many previous studies adopt both *SHO* and *TERM* simultaneously (e.g., Chen et al., 1986; Ferson and Harvey, 1991). Table A1 provides empirical evidence that the output gap is still negatively significant for all results. We observe that *SHO* is positively linked to the price of *HML* risk, which suggests that an increase in the short-term interest rate causes an increase in the value price. This indicates that value firms are burdened with unproductive real capital and are sensitive to

[20] Tables A36-A38 adopt the dividend-price ratio (*DP*) and the default spread (*DEF*) as state variables (e.g., Adrian et al., 2015; Cooper et al., 2022).

changes in the interest rates (Zhang, 2005; Cooper, 2006; Bai et al., 2019). In three out of the four results, *UNC* is positively associated with the price of *SMB* risk, which suggests that small firms require a higher price of risk during periods of high economic uncertainty. This is related to the growth opportunities of small firms being influenced more strongly by economic uncertainties (Carlson et al., 2004; Garleanu et al., 2012).

Table A2 reports the results for the five factor-model, and we confirm that *GAP* is the most important variable for the time-varying price of *MKT* risk. Table A3 demonstrates that *GAP* remains significant for the *q*-factor model. Another notable point is that *SHO* is positively associated with the price of *R_IV* risk, which is consistent with the results in Table A1. This is linked to the results of Hou et al. (2015) who show that low-investment firms are value firms. The reason is that value firms tend not to have high profitability projects and invest less than growth firms.

5.2. *Risk factors, state variables and time-variation*

Furthermore, we explore relative importance across risk factors, state variables and time variation of prices of risk. Table 8 shows the relative RMSPE against the standard CAPM without time variation of the price of risk. We find that the time-varying price of risk leads to reduction of the average RMSPE by 3% (TVP-1F). Adding factors into the CAPM contributes to further reduction of RMSPEs. For instance, the four-factor model without time-varying prices of risk reduces the average RMSPE by 32% (4F). This reduction is also observed by the five-factor and *q*-factor models. Importantly, the time variations of prices of risk lead to further reduction of the RMSPEs by 7% (4F-TVP1, 5F-TVP1, q-TVP1), which are consistent with the results in Table 5. The average RMSPEs for 4F-TVP1 and 4F-TVP2 are not different, which indicates that the output gap has dominant effects.[21]

Moreover, we investigate whether the global output gap leads to further reduction of RMSPEs. Atanasov (2018) reports that the global output gap is more important than individual countries' output gaps for stock market prices of risk. We replace the individual output gap with the global output gap, and find that this change does not impact the results for all three models (4F-TVP1-G, 5F-TVP1-G, q-TVP1-G).

Tables A23-A26 report the comparison results for European and Japanese markets. We find that time-varying prices of risk have greater impacts in terms of the RMSPE reduction for European results.

Overall, employing several risk factors has the highest impact in the RMSPE reduction from the CAPM, whereas adding time-varying prices of risk generate further 5

[21] Table A22 reports the results using other test portfolios and we observe the same pattern.

to 10% reduction of the RMSPE.

6. Conclusion

This study investigates how the output gap affects time-varying prices of risk. We employ a time-varying price of risk model proposed by Adrian et al. (2015), which allows us to track a change in the price of risk and determine the important state variable for this change to occur, without setting an arbitrarily selected window size of rolling regressions.

We find that the output gap is the main driving force of the time-varying market price of risk. Moreover, it is linked to the time variation of the price of momentum risk but the exposures to the output gap have the opposite effect when compared with the market risk. This is related to the finding of Barroso and Santa-Clara (2015) and Daniel and Moskowitz (2016) that momentum risk provides the negative exposures to market risk. We note that the average prices of the market and momentum of risks are both positive, while the timing of increasing the prices of risk is different. This is in line with the finding of Grundy and Martin (2001), but we uncover the driving force behind the time variations. Our results are supported by the theoretical models showing that past winner firms are more sensitive to changes in business cycles, which is proposed by Johnson (2002), Liu and Zhang (2014) and Li (2018). Although the output gaps strongly impact the price of market risk, the relationships between the prices of momentum risk and the output gaps are weak for European and Japanese portfolios, indicating heterogeneities across regions. We also observe that the price of value risk is not linked to the output gaps for all regions.

Our results suggest that once investors estimate the current level of the output gap, they can assess whether the price of market risk or that of momentum risk has a dominant impact in a current state. These findings allow investors to change their strategies based on market states. This is an important deviation from the previous studies that adopt conditional factor models. Moreover, our results provide information for investors who invest in European and Japanese stock markets. They can evaluate whether the price of market risk is positive or not based on the current output gap level.

References

Ang, A., and Bekaert, G. (2007). Stock return predictability: Is it there? *Review of Financial Studies, 20,* 651–707.

Adra, S., & Menassa, E. (2023). Uncertainty and corporate investments in response to the Fed's dual shocks. *Financial Review,* 58, 463-484.

Adrian, T., Crump, R.K., and Moench, E. (2015). Regression-based estimation of dynamic asset pricing models. *Journal of Financial Economics*, 118, 211-244.

Adrian, T., Crump, R.K., and Vogt, E. (2019). Nonlinearity and flight to safety in the risk-return trade-off for stocks and bonds. *Journal of Finance*, 74, 1931-1973.

Atanasov, V. (2018). World output gap and global stock returns. *Journal of Empirical Finance*, 48, 181-197.

Atanasov, V., Møller, S.V. and Priestley, R. (2020). Consumption fluctuations and expected returns. *Journal of Finance*, 75, 1677-1713.

Bai, H., Hou, K., Kung, H., Li, E.X.N., and Zhang, L. (2019). The CAPM strikes back? An equilibrium model with disasters, *Journal of Financial Economics*, 131, 269-298.

Bali, T. G., Brown, S. J., and Tang, Y. (2017). Is economic uncertainty priced in the cross-section of stock returns? *Journal of Financial Economics*, 126, 471-489.

Bansal, R., Kiku, D., Shaliastovich, I., and Yaron, A. (2014). Volatility, the macroeconomy, and asset prices. *Journal of Finance*, 69, 2471-2511.

Barroso, P and Santa-Clara, P. (2015). Momentum has its moments. *Journal of Financial Economics*, 116, 111-120.

Bekaert, G. and Engstrom, E. (2010). Inflation and the stock market: Understanding the "Fed Model". *Journal of Monetary Economics*, 57, 278-294.

Bernanke, B.S. (2020). The new tools of monetary policy. *American Economic Review*, 110, 943-83.

Breen, W., Glosten, L.R., and Jagannathan, R. (1989). Economic significance of predictable variations in stock index returns. *Journal of Finance*, 44, 1177–1189.

Bruno, V. and Shin, H.S. (2015). Capital flows and the risk-taking channel of monetary policy, *Journal of Monetary Economics*, 71, 119-132.

Burnside, C. (2011). The cross section of foreign currency risk premia and consumption growth risk: comment. *American Economic Review*, 101, 3456-76.

Byrne, J.P., Ibrahim, B.M., and Sakemoto, R. (2017). The time-varying risk price of currency carry trades. MPRA Working Paper, No. 80788.

Byrne, J.P., Ibrahim, B.M., and Sakemoto, R. (2022). The time-varying risk price of currency portfolios. *Journal of International Money and Finance*, 124, 102636.

Campbell, J.Y. (1996). Understanding risk and return. *Journal of Political Economy*, 104, 298-345.

Campbell, J.Y. and Cochrane, J.H. (1999). By force of habit: A consumption-based explanation of aggregate stock market behavior. *Journal of Political Economy*, 107, 205–51.

Campbell, J.Y., Pflueger, C., and Viceira, L.M. (2020). Macroeconomic drivers of bond and equity risks. *Journal of Political Economy*,128(8), 3148-3185.

Carhart, M. (1997). On persistence in mutual fund performance. *Journal of Finance,* 52, 57-82.

Carlson, M., Fisher, A., and Giammarino, R. (2004). Corporate investment and asset price dynamics: Implications for the cross-section of returns. *Journal of Finance,* 59, 2577-2603.

Chen, N-F., Roll, R. and Ross, S. A. (1986). Economic forces and the stock market. *Journal of Business*, 59, 383-403.

Chordia, T., and Shivakumar, L. (2002). Momentum, business cycle, and time-varying expected returns. *Journal of Finance*, 57(2), 985-1019.

Clarida, R., Gali, J., and Gertler, M. (2000). Monetary policy rules and macroeconomic stability: Evidence and some theory. *Quarterly Journal of Economics*, 115(1), 147-180.

Cochrane, J. (1996). A cross-sectional test of an investment-based asset pricing model. *Journal of Political Economy*,104(3), 572-621.

Cochrane, J. (2021). Rethinking production under uncertainty, *Review of Asset Pricing Studies*, 11(1), 1-59.

Colacito, R., Riddiough, S., and Sarno, L. (2020). Business cycles and currency returns. *Journal of Financial Economics*, 137, 659-678.

Cooper, I. (2006). Asset pricing implications of nonconvex adjustment costs and irreversibility of investment. *Journal of Finance*, 61(1), 139-170.

Cooper, I. and Maio, P. (2019). New evidence on conditional factor model. *Journal of Financial and Quantitative Analysis*, 54(5), 1975-2016.

Cooper, I., Mitrache, A., and Priestley, R. (2022). A global macroeconomic risk model for value, momentum, and other asset classes. *Journal of Financial and Quantitative Analysis*, 57, 1-30.

Cooper, I. and Priestley, R. (2009). Time-varying risk premiums and the output gap. *Review of Financial Studies*, 22, 2801-2833.

Cooper, I. and Priestley, R. (2011). Real investment and risk dynamics. *Journal of Financial Economics*, 101, 182-205.

Daniel, K. and Moskowitz, T.J. (2016). Momentum crashes. *Journal of Financial Economics*, 122, 221-247.

DeStefano, M. (2004). Stock Returns and the Business Cycle, *Financial Review,* 39(4), pages 527-547.

Donthu, N. and Gustafsson, A. (2020). Effects of COVID-19 on business and research. *Journal of Business Research,* 117, 284-289.

Estrella, A. and Hardouvelis, G. (1991). The term structure as a predictor of real economic activity. *Journal of Finance*, 46(2), 555-576.

Fama, E.F. and French, K.R. (1992). The cross-section of expected stock returns. *Journal of Finance*, 47, 427-465.

Fama, E.F. and French, K.R. (1993). Common risk factors in the returns on stock and bonds. *Journal of Financial Economics*, 33, 3-56.

Fama, E.F. and French, K.R. (2012). Size, value, and momentum in international stock returns. *Journal of Financial Economics*, 105, 457-472.

Fama, E.F. and French, K.R. (2015). A five-factor asset pricing model. *Journal of Financial Economics*, 116, 1-22.

Fama, E.F. and French, K.R. (2017). International tests of a five-factor asset pricing model. *Journal of Financial Economics*, 123, 441-463.

Fama, E.F. and French, K.R. (2018). Choosing factors. *Journal of Financial Economics*, 128, 234-252.

Fama, E.F. and MacBeth, J.D. (1973). Risk, return, and equilibrium: Empirical tests. *Journal of Political Economy*, 81, 607-636.

Fatás, A. and Summers, L.H. (2018). The permanent effects of fiscal consolidations. *Journal of International Economics*, 112, 238-250.

Ferson, W.E. (2019). Empirical asset pricing. MIT press, Cambridge, MA.

Ferson, W.E. and Harvey, C.R. (1991). The variation of economic risk premiums. *Journal of Political Economy*, 99, 385-415.

Ferson, W.E. and Harvey, C.R. (1999). Conditional variables and the cross section of stock returns. *Journal of Finance*, 54, 1325-1360.

Fuhrer, J. and Rudebusch, G. (2004). Estimating the Euler equation for output. *Journal of Monetary Economics*, 51(6), 1133-1153.

Garleanu, N., Panageas, S., and Yu, J. (2012). Technological growth and asset pricing. *Journal of Finance*, 67, 1265-1292.

Griffin, J.M., Ji, X., and Martin, J.S. (2003). Momentum investing and business cycle risk: Evidence from pole to pole. *Journal of Finance*, 58, 2525-2547.

Grundy, B.D. and Martin, J.S. (2001). Understanding the nature of the risks and the source of the rewards to momentum investing. *Review of Financial Studies*, 14, 29-78.

Hamilton, J.D. (2018). Why you should never use the Hodrick-Prescott filter. *Review of Economics and Statistics*, 100, 831-843.

Hodrick, R.J. and Prescott, E.C. (1997). Postwar U.S. business cycles: an empirical investigation. *Journal of Money, Credit and Banking*, 29, 1-16.

Hollstein, F., Prokopczuk, M., and Wese Simen, C. (2020). The conditional CAPM revisited: Evidence from high-frequency betas. *Management Science*, 66, 2474-2494.

Hou, K., Mo, H, Xue, C., and Zhang, L. (2021). An augmented *q*-factor model with expected growth, *Review of Finance*, 25, 1-41.

Hou, K., Xue, C., and Zhang, L. (2015). Digesting anomalies: An investment approach. *Review of Financial Studies*, 28(3), 650-705.

Jagannathan, R. and Wang, Z. (1996). The conditional CAPM and the cross-section of expected Returns. *Journal of Finance*, 51, 3-53.

Johnson, T.C. (2002). Rational momentum effects. *Journal of Finance*, 57, 585-608.

Jurado, K., and Ludvigson, S.C., and Ng, S., (2015). Measuring uncertainty. *American Economic Review*, 105, 1177-1216.

Karolyi, G.A. and Wu, Y. (2018). A new partial-segmentation approach to modeling international stock returns. *Journal of Financial and Quantitative Analysis*, 53, 507-546.

Kose, M.A., Otrok, C. and Prasad, E. (2012) Global business cycles: Convergence or decoupling? *International Economic Review*, 53,511-538.

Kilian, L. and Zhou, X. (2018). Modeling fluctuations in the global demand for commodities. *Journal of International Money and Finance*, 88, 54-78.

Lettau, M. and Ludvigson, S.C. (2001a). Resurrecting the (C)CAPM: a cross-sectional test when risk premia are time-varying. *Journal of Political Economy*, 109, 1238-1287.

Lettau, M. and Ludvigson, S.C. (2001b). Consumption, aggregate wealth, and expected stock returns. *Journal of Finance*, 56, 815-849.

Lewellen, J. and Nagel, S. (2006). The conditional CAPM does not explain asset pricing anomalies. *Journal of Financial Economics*, 82, 289-314.

Lewellen, J., Nagel, S. and Shanken, J. (2010). A skeptical appraisal of asset pricing tests. *Journal of Financial Economics*, 96, 175-194.

Li, J. (2018). Explaining momentum and value simultaneously. *Management Science*, 64, 4239-4260.

Lintner, J. (1965). The valuation of risk assets and the selection of risky investments in stock portfolios and capital budgets. *Review of Economics and Statistics*, 47, 13–37.

Liu, L. X. and Zhang, L. (2008). Momentum profits, factor pricing, and macroeconomic risk. *Review of Financial Studies*, 21(6), 2417-2448.

Liu, L. X. and Zhang, L. (2014). A neoclassical interpretation of momentum. *Journal of Monetary Economics*, 67, 109-128.

Ludvigson, C. and Ng, S. (2007). The empirical risk-return relation: A factor analysis approach. *Journal of Financial Economics,* 83, 171-222.

Martin, A. and Ventura, J. (2012). Economic growth with bubbles. *American Economic Review*, 102, 3033-58**.**

Miranda-Agrippino, S. and Rey, H. (2020). U.S. monetary policy and the global financial cycle, *Review of Economic Studies*, 87, 6, 2754-2776.

Pesaran, M. and Timmermann, A. (1995). Predictability of stock returns: robustness and economic significance, *Journal of Finance*, 50, 1201-28.

Rapach, D.E., Strauss, J.K., and Zhou, G. (2013). International stock return predictability: What is the role of the United States? *Journal of Finance,* 68, 1633-1662.

Sagi, J.S. and Seasholes, M.S. (2007). Firm-specific attributes and the cross-section of momentum, *Journal of Financial Economics*, 84, 389-434.

Sakemoto, R. (2023). The long-run risk premium in the intertemporal CAPM: International evidence. *Journal of International Financial Markets, Institutions and Money,* 89, 101854.

Schularick, M. and Taylor, A.M. (2012). Credit booms gone bust: Monetary policy, leverage cycles, and financial crises, 1870-2008. *American Economic Review*, 102, 1029-61.

Sharpe, W.F. (1964). Capital asset prices: A theory of market equilibrium under conditions of risk. *Journal of Finance*, 19, 425–442.

Vassalou, M. (2003). News related to future GDP growth as a risk factor in equity returns. *Journal of Financial Economics*, 68(1), 47-73.

Yogo, M. (2006). A consumption-based explanation of expected stock returns. *Journal of Finance*, 61(2), 539-580.

Zhang, L. (2005). The value premium. *Journal of Finance*, 60(1), 67-103.

Table 1 Price of Risk Parameter Estimates

			const		*GAP*		mean		R^2
(a)	Size-B/M	*MKT*	0.68	***	-8.11	***	0.64	*	-0.54
			(0.18)		(2.82)		(0.33)		
(b)	Size-OP	*MKT*	0.66	***	-8.03	***	0.62	*	-0.20
			(0.18)		(2.79)		(0.33)		
(c)	Size-INV	*MKT*	0.69	***	-8.15	***	0.65	*	-0.66
			(0.18)		(2.81)		(0.33)		
(d)	Size-MOM	*MKT*	0.62	***	-8.88	***	0.58		-0.28
			(0.18)		(2.82)		(0.36)		

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factor is the market (*MKT*) and the state variable is the U.S. output gap (*GAP*) calculated by Equation (6). The column "mean" indicates the average price of risk in Equation (5). The R^2 is calculated using Equation (10). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 2 Price of Risk Parameter Estimates: Four Factor Model

		const	*GAP*	*TERM*	*DEI*	*UI*	mean	R^2
(a) Size-B/M	*MKT*	0.49	-7.25 **	0.10	-0.69 **	0.18	0.61 *	0.66
		(0.31)	(3.16)	(0.17)	(0.27)	(0.32)	(0.33)	
	SMB	-0.03	1.61	0.15	-0.23	-0.17	0.21	
		(0.22)	(2.25)	(0.12)	(0.19)	(0.22)	(0.14)	
	HML	0.14	1.35	0.12	0.23	0.23	0.33 **	
		(0.20)	(2.10)	(0.11)	(0.18)	(0.21)	(0.13)	
	UMD	-0.43	22.89 *	2.37 ***	-0.34	0.42	3.31 ***	
		(1.14)	(12.61)	(0.79)	(0.95)	(1.06)	(1.01)	
(b) Size-OP	*MKT*	0.54 *	-7.59 **	0.04	-0.72 ***	0.19	0.57 *	0.52
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.32)	
	SMB	-0.05	2.54	0.13	-0.13	-0.17	0.16	
		(0.22)	(2.21)	(0.12)	(0.19)	(0.22)	(0.13)	
	HML	-0.24	-0.06	0.51 **	0.22	0.12	0.55 *	
		(0.34)	(4.09)	(0.20)	(0.32)	(0.35)	(0.29)	
	UMD	0.79	12.48	0.61	0.53	0.36	1.78 ***	
		(1.03)	(10.62)	(0.59)	(0.94)	(0.97)	(0.65)	
(c) Size-INV	*MKT*	0.51	-7.44 **	0.08	-0.75 ***	0.16	0.59 *	0.69
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)	
	SMB	-0.07	1.71	0.14	-0.11	-0.19	0.15	
		(0.22)	(2.26)	(0.12)	(0.19)	(0.23)	(0.13)	
	HML	0.33	0.86	0.16	0.14	0.28	0.58 ***	
		(0.25)	(2.68)	(0.14)	(0.22)	(0.25)	(0.15)	
	UMD	0.18	23.30 **	0.99 *	-0.32	-1.27	1.80 **	
		(0.96)	(11.32)	(0.57)	(0.93)	(1.04)	(0.79)	
(d) Size-MOM	*MKT*	0.55 *	-7.64 **	0.04	-0.69 **	0.16	0.58 *	0.86
		(0.31)	(3.17)	(0.16)	(0.27)	(0.32)	(0.33)	
	SMB	0.02	1.69	0.12	-0.16	-0.22	0.21	
		(0.23)	(2.39)	(0.12)	(0.20)	(0.24)	(0.14)	
	HML	-0.03	0.30	0.42 **	-0.01	0.51	0.62 **	
		(0.35)	(3.92)	(0.19)	(0.29)	(0.33)	(0.25)	
	UMD	0.69 **	5.17 *	0.03	0.34	0.24	0.76 ***	
		(0.30)	(3.04)	(0.16)	(0.26)	(0.30)	(0.25)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The column "mean" indicates the average price of risk in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 3 Price of Risk Parameter Estimates: Five Factor Model

		const	*GAP*	*TERM*	*DEI*	*UI*	mean	R^2
(a) Size-B/M	*MKT*	0.49	-7.57 **	0.01	-0.71 ***	0.12	0.48	0.53
		(0.31)	(3.17)	(0.16)	(0.27)	(0.32)	(0.32)	
	SMB	-0.02	1.30	0.20 *	-0.17	-0.09	0.30 **	
		(0.22)	(2.20)	(0.12)	(0.19)	(0.22)	(0.13)	
	HML	0.17	0.99	0.04	0.23	0.16	0.23 *	
		(0.20)	(2.09)	(0.11)	(0.18)	(0.21)	(0.13)	
	RMW	0.02	-2.09	0.23	0.40	0.48	0.36	
		(0.34)	(3.41)	(0.19)	(0.28)	(0.34)	(0.23)	
	CMA	-0.31	7.29 **	0.31 *	-0.22	0.00	0.19	
		(0.32)	(3.32)	(0.18)	(0.27)	(0.33)	(0.23)	
(b) Size-OP	*MKT*	0.53 *	-7.77 **	0.04	-0.72 ***	0.18	0.56 *	0.82
		(0.31)	(3.15)	(0.16)	(0.27)	(0.32)	(0.33)	
	SMB	-0.04	2.63	0.14	-0.13	-0.16	0.18	
		(0.22)	(2.22)	(0.12)	(0.19)	(0.23)	(0.13)	
	HML	-0.31	-1.33	0.27 *	0.12	0.01	0.09 *	
		(0.29)	(2.93)	(0.16)	(0.26)	(0.30)	(0.20)	
	RMW	0.00	0.24	0.13	0.14	0.06	0.21 **	
		(0.16)	(1.59)	(0.06)	(0.14)	(0.16)	(0.09)	
	CMA	-0.03	4.97	0.06	0.13	0.59 *	0.10	
		(0.31)	(3.58)	(0.18)	(0.25)	(0.32)	(0.26)	
(c) Size-INV	*MKT*	0.52 *	-7.60 **	0.06	-0.76 ***	0.17	0.57 *	0.55
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)	
	SMB	-0.05	0.83	0.12	-0.06	-0.18	0.13	
		(0.23)	(2.29)	(0.12)	(0.20)	(0.23)	(0.13)	
	HML	-0.07	8.09	0.49 *	-0.05	0.27	0.72 **	
		(0.47)	(5.05)	(0.27)	(0.40)	(0.45)	(0.30)	
	RMW	-0.12	-2.12	0.03	0.34	0.09	-0.08	
		(0.41)	(4.49)	(0.23)	(0.32)	(0.36)	(0.22)	
	CMA	0.29 **	-0.32	-0.06	0.12	0.07	0.20 **	
		(0.15)	(1.57)	(0.08)	(0.14)	(0.16)	(0.08)	
(d) Size-MOM	*MKT*	0.55 *	-7.69 **	0.05	-0.81 ***	0.09	0.58 *	0.85
		(0.32)	(3.22)	(0.17)	(0.28)	(0.32)	(0.34)	
	SMB	0.18	2.52	0.15	0.01	-0.05	0.42 ***	
		(0.24)	(2.44)	(0.12)	(0.21)	(0.25)	(0.16)	
	HML	-0.92 *	-4.03	0.22	-0.53	-0.19	-0.61	
		(0.53)	(4.77)	(0.24)	(0.46)	(0.47)	(0.46)	
	RMW	0.29	1.96	0.04	0.99 **	0.76 *	0.37	
		(0.50)	(4.82)	(0.23)	(0.40)	(0.41)	(0.44)	
	CMA	0.37	3.38	0.32	-0.88 **	-0.18	0.88 **	
		(0.52)	(5.52)	(0.26)	(0.41)	(0.48)	(0.42)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*), as proposed by Fama and French (2015). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The column "mean" indicates the average price of risk in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 4 Price of Risk Parameter Estimates: *q*-Factor Model

		const	*GAP*	*TERM*	*DEI*	*UI*	mean	R^2
(a) Size-B/M	*MKT*	0.48	-8.03 **	0.02	-0.66 **	0.17	0.49	0.52
		(0.33)	(3.27)	(0.17)	(0.28)	(0.33)	(0.33)	
	R_ME	-0.19	2.18	0.34 ***	-0.17	-0.04	0.36 **	
		(0.24)	(2.39)	(0.13)	(0.20)	(0.24)	(0.15)	
	R_IA	0.02	1.94	0.18	0.23	0.27	0.31 **	
		(0.22)	(2.22)	(0.12)	(0.19)	(0.21)	(0.13)	
	R_ROE	-0.37	2.49	0.53 **	0.17	0.44	0.49 **	
		(0.40)	(4.12)	(0.23)	(0.32)	(0.39)	(0.25)	
(b) Size-OP	*MKT*	0.46	-7.69 **	0.07	-0.71 **	0.20	0.55 *	0.79
		(0.33)	(3.24)	(0.17)	(0.28)	(0.32)	(0.33)	
	R_ME	-0.15	2.46	0.23 *	-0.07	-0.14	0.23 *	
		(0.25)	(2.40)	(0.13)	(0.21)	(0.24)	(0.14)	
	R_IA	-0.17	-0.91	0.17	0.05	0.10	0.11	
		(0.27)	(2.72)	(0.14)	(0.23)	(0.26)	(0.17)	
	R_ROE	0.00	0.58	0.26 *	0.26	0.08	0.42 **	
		(0.27)	(2.96)	(0.15)	(0.28)	(0.28)	(0.17)	
(c) Size-INV	*MKT*	0.45	-7.73 **	0.07	-0.74 ***	0.19	0.54	0.53
		(0.33)	(3.24)	(0.17)	(0.28)	(0.32)	(0.33)	
	R_ME	-0.21	2.47	0.30 **	-0.03	-0.12	0.27 *	
		(0.24)	(2.35)	(0.12)	(0.21)	(0.24)	(0.14)	
	R_IA	0.25	1.01	0.04	0.10	0.14	0.32 ***	
		(0.17)	(1.63)	(0.09)	(0.14)	(0.16)	(0.09)	
	R_ROE	-0.43	4.21	0.47 **	0.29	0.20	0.34 *	
		(0.38)	(3.86)	(0.20)	(0.31)	(0.34)	(0.20)	
(d) Size-MOM	*MKT*	0.44	-7.99 **	0.06	-0.68 **	0.16	0.52	0.89
		(0.33)	(3.30)	(0.17)	(0.28)	(0.33)	(0.34)	
	R_ME	0.13	2.70	0.21	-0.08	-0.09	0.47 ***	
		(0.27)	(2.55)	(0.14)	(0.22)	(0.26)	(0.15)	
	R_IA	-0.34	-0.38	0.30	-0.15	0.29	0.14	
		(0.35)	(3.59)	(0.19)	(0.25)	(0.29)	(0.23)	
	R_ROE	0.69 **	4.22	0.01	0.33	0.29	0.71 ***	
		(0.32)	(3.22)	(0.16)	(0.25)	(0.30)	(0.25)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*R_ME*), investment (*R_IV*) and profitability (*R_ROE*), as proposed by Hou et al. (2015). The state variables are the U.S. output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The column "mean" indicates the average price of risk in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from January 1967 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 5 RMSPE Relative to the Constant Price of Risk Model

Panel A: 4 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.94	0.95	0.88	0.90	0.90	Small	0.96	0.93	0.90	0.91	0.91
2	0.90	0.87	0.88	0.85	0.88	2	0.94	0.90	0.88	0.89	0.92
3	0.86	0.87	0.89	0.87	0.92	3	0.94	0.89	0.86	0.87	0.92
4	0.88	0.89	0.92	0.91	0.92	4	0.94	0.89	0.88	0.88	0.91
Big	0.83	0.88	0.93	0.94	0.96	Big	0.93	0.86	0.87	0.84	0.85

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.96	0.90	0.90	0.92	0.92	Small	0.93	0.90	0.91	0.91	0.94
2	0.89	0.89	0.86	0.86	0.89	2	0.88	0.88	0.89	0.87	0.89
3	0.92	0.88	0.87	0.89	0.86	3	0.90	0.86	0.85	0.90	0.92
4	0.91	0.87	0.86	0.90	0.89	4	0.89	0.85	0.87	0.91	0.93
Big	0.92	0.87	0.84	0.86	0.88	Big	0.90	0.86	0.88	0.90	0.93

Panel B: 5 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.94	0.93	0.88	0.90	0.90	Small	0.95	0.93	0.90	0.90	0.90
2	0.90	0.87	0.87	0.84	0.88	2	0.91	0.90	0.87	0.86	0.88
3	0.85	0.87	0.89	0.87	0.92	3	0.91	0.88	0.85	0.84	0.89
4	0.88	0.88	0.92	0.91	0.92	4	0.91	0.88	0.88	0.85	0.89
Big	0.82	0.87	0.92	0.94	0.96	Big	0.89	0.85	0.87	0.83	0.80

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.94	0.90	0.90	0.92	0.92	Small	0.96	0.92	0.92	0.91	0.95
2	0.87	0.89	0.85	0.84	0.88	2	0.95	0.92	0.88	0.88	0.93
3	0.91	0.86	0.86	0.88	0.84	3	0.96	0.90	0.85	0.89	0.96
4	0.89	0.87	0.86	0.90	0.88	4	0.95	0.91	0.87	0.90	0.97
Big	0.89	0.84	0.83	0.85	0.85	Big	0.96	0.92	0.88	0.90	0.97

Panel C: q factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.95	0.94	0.88	0.90	0.92	Small	0.95	0.93	0.92	0.92	0.92
2	0.92	0.89	0.88	0.88	0.92	2	0.93	0.91	0.89	0.90	0.92
3	0.89	0.87	0.91	0.90	0.95	3	0.93	0.88	0.86	0.88	0.91
4	0.89	0.89	0.94	0.93	0.95	4	0.92	0.89	0.89	0.89	0.90
Big	0.85	0.89	0.94	0.97	0.98	Big	0.93	0.87	0.88	0.84	0.83

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.94	0.90	0.90	0.92	0.92	Small	0.95	0.92	0.92	0.91	0.95
2	0.87	0.90	0.86	0.87	0.90	2	0.94	0.92	0.91	0.89	0.94
3	0.92	0.87	0.88	0.88	0.86	3	0.95	0.91	0.88	0.91	0.95
4	0.90	0.89	0.87	0.90	0.88	4	0.95	0.91	0.90	0.91	0.96
Big	0.90	0.85	0.85	0.86	0.86	Big	0.96	0.93	0.90	0.90	0.96

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the constant price of risk model proposed by Fama and MacBeth (1973). Time-varying price of risk model is estimated using Equation (4), as proposed by Adrian et al. (2015). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. Panel A is the four-factor model, Panel B is the five-factor model and Panel C is the *q*-factor model. The state variables are the U.S. output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*).

Table 6 Price of Risk Parameter Estimates: Four Factor Model in Europe

Europe		const	*GAP*	*TERM*	*DEI*	*UI*	mean	R^2
(a) Size-B/M	*MKT*	0.64 **	-1.84 **	-0.03	0.11	-0.59	0.55 *	0.26
		(0.28)	(0.80)	(0.16)	(0.13)	(1.83)	(0.28)	
	SMB	-0.03	-0.46	0.14 *	0.00	0.36	-0.01	
		(0.12)	(0.37)	(0.07)	(0.06)	(0.81)	(0.13)	
	HML	0.21	0.89 **	0.06	0.07	-0.71	0.18	
		(0.14)	(0.44)	(0.08)	(0.07)	(0.94)	(0.16)	
	UMD	1.71 ***	4.19 **	-0.08	0.22	-4.22	1.54 **	
		(0.66)	(1.71)	(0.38)	(0.19)	(2.95)	(0.70)	
(b) Size-OP	*MKT*	0.65 **	-1.86 **	-0.03	0.11	-0.61	0.57 **	0.34
		(0.28)	(0.79)	(0.16)	(0.13)	(1.83)	(0.29)	
	SMB	0.05	-0.50	0.14 *	0.00	0.33	0.06	
		(0.13)	(0.36)	(0.08)	(0.06)	(0.81)	(0.13)	
	HML	0.07	-0.03	-0.15	0.07	1.61	0.16	
		(0.24)	(0.57)	(0.13)	(0.09)	(1.19)	(0.28)	
	UMD	2.60 ***	0.48	-0.60	0.20	0.95	2.65 ***	
		(0.75)	(1.44)	(0.39)	(0.22)	(3.00)	(0.78)	
(c) Size-INV	*MKT*	0.60 **	-1.86 **	-0.02	0.11	-0.58	0.51 *	0.27
		(0.27)	(0.79)	(0.16)	(0.13)	(1.83)	(0.28)	
	SMB	0.03	-0.48	0.14 *	0.00	0.17	0.03	
		(0.12)	(0.36)	(0.08)	(0.06)	(0.82)	(0.13)	
	HML	0.39 **	0.85	0.09	0.14 *	1.34	0.48 *	
		(0.19)	(0.60)	(0.13)	(0.08)	(1.18)	(0.29)	
	UMD	0.44	2.13	0.40	-0.09	-4.01	0.25	
		(0.65)	(2.00)	(0.45)	(0.24)	(3.90)	(0.69)	
(d) Size-MOM	*MKT*	0.59 **	-1.85 **	-0.03	0.10	-0.65	0.50 *	0.75
		(0.28)	(0.79)	(0.16)	(0.13)	(1.83)	(0.28)	
	SMB	0.13	-0.52	0.14 *	-0.01	0.27	0.13	
		(0.13)	(0.37)	(0.08)	(0.06)	(0.83)	(0.14)	
	HML	0.71 *	0.86	-0.07	0.22 *	1.45	0.80 *	
		(0.37)	(1.05)	(0.24)	(0.13)	(1.85)	(0.45)	
	UMD	0.96 ***	0.93	-0.14	0.02	-0.54	0.95 ***	
		(0.22)	(0.64)	(0.13)	(0.10)	(1.47)	(0.22)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The column "mean" indicates the average price of risk in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 7 Price of Risk Parameter Estimates: Four Factor Model in Japan

Japan									
			const	*GAP*	*TERM*	*DEI*	*UI*	mean	R^2
(a)	Size-B/M	*MKT*	0.09	-9.56 **	0.14	0.96	0.03	0.12	0.49
			(0.29)	(4.46)	(1.77)	(1.39)	(0.15)	(0.32)	
		SMB	0.13	-4.86 *	0.09	0.43	0.01	0.15	
			(0.17)	(2.66)	(1.07)	(0.84)	(0.09)	(0.21)	
		HML	0.21	2.79	-0.13	0.09	-0.11	0.24	
			(0.16)	(2.48)	(1.01)	(0.78)	(0.08)	(0.17)	
		UMD	0.78	0.12	2.30	0.10	-0.18	0.84	
			(0.66)	(8.74)	(5.25)	(2.73)	(0.28)	(0.66)	
(b)	Size-OP	*MKT*	0.09	-9.69 **	-0.07	0.97	0.02	0.13	0.56
			(0.29)	(4.47)	(1.76)	(1.39)	(0.15)	(0.32)	
		SMB	0.21	-6.69 ***	0.04	0.86	0.04	0.23	
			(0.17)	(2.72)	(1.08)	(0.86)	(0.09)	(0.22)	
		HML	-0.42	16.86 ***	-0.77	-2.92 *	-0.23	-0.43	
			(0.31)	(5.77)	(1.98)	(1.54)	(0.19)	(0.44)	
		UMD	0.59	4.92	-1.51	-2.10	-0.27	0.65	
			(0.65)	(11.40)	(4.67)	(3.15)	(0.32)	(0.67)	
(c)	Size-INV	*MKT*	0.06	-9.86 **	-0.08	0.92	0.03	0.09	0.52
			(0.29)	(4.46)	(1.76)	(1.39)	(0.15)	(0.32)	
		SMB	0.18	-5.38 **	-0.05	0.70	0.01	0.20	
			(0.17)	(2.67)	(1.07)	(0.86)	(0.09)	(0.21)	
		HML	0.06	14.15 ***	-0.94	-1.53	-0.06	0.02	
			(0.24)	(4.14)	(1.77)	(1.13)	(0.13)	(0.36)	
		UMD	0.39	3.96	0.75	-1.88	0.04	0.35	
			(0.51)	(8.42)	(3.34)	(2.25)	(0.25)	(0.50)	
(d)	Size-MOM	*MKT*	0.04	-9.25 **	0.35	0.88	0.04	0.06	0.63
			(0.29)	(4.47)	(1.78)	(1.40)	(0.15)	(0.32)	
		SMB	0.26	-8.27 ***	0.79	0.68	0.06	0.28	
			(0.18)	(3.02)	(1.13)	(0.91)	(0.10)	(0.25)	
		HML	-0.03	12.54 *	-3.88	0.75	-0.24	0.00	
			(0.39)	(7.00)	(3.20)	(1.79)	(0.20)	(0.45)	
		UMD	0.13	4.32	2.23	-0.48	0.11	0.07	
			(0.24)	(3.69)	(1.44)	(1.13)	(0.12)	(0.25)	

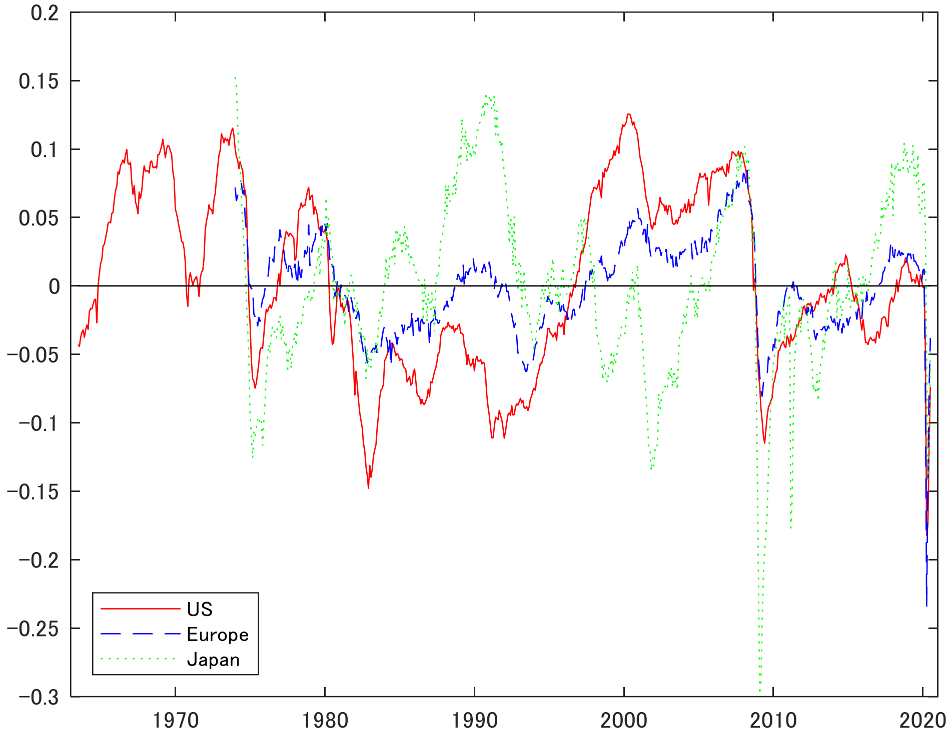
Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The column "mean" indicates the average price of risk in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table 8 RMSPE Comparison: factors, time-variation and state variables

US: Size-B/M														
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP-G	5F	5F-TVP1	5F-TVP2	5F-TVP-G	q	q-TVP1	q-TVP2	q-TVP-G
P1	1.00	0.99	0.61	0.57	0.56	0.56	0.58	0.54	0.53	0.53	0.65	0.61	0.61	0.61
P2	1.00	0.99	0.55	0.52	0.51	0.51	0.51	0.48	0.47	0.47	0.54	0.51	0.51	0.50
P3	1.00	0.98	0.52	0.46	0.46	0.45	0.52	0.46	0.45	0.45	0.54	0.48	0.48	0.47
P4	1.00	0.99	0.51	0.46	0.45	0.44	0.51	0.46	0.45	0.45	0.54	0.49	0.49	0.48
P5	1.00	0.99	0.54	0.49	0.48	0.48	0.54	0.49	0.49	0.48	0.62	0.57	0.57	0.56
P6	1.00	0.98	0.54	0.48	0.47	0.48	0.54	0.49	0.48	0.48	0.63	0.58	0.57	0.58
P7	1.00	0.98	0.57	0.49	0.49	0.49	0.56	0.49	0.48	0.48	0.60	0.53	0.53	0.52
P8	1.00	0.98	0.61	0.54	0.53	0.53	0.59	0.51	0.51	0.50	0.66	0.58	0.58	0.58
P9	1.00	0.98	0.55	0.47	0.47	0.46	0.55	0.47	0.46	0.46	0.66	0.58	0.58	0.58
P10	1.00	0.99	0.50	0.44	0.44	0.43	0.49	0.43	0.43	0.42	0.63	0.58	0.58	0.57
P11	1.00	0.97	0.61	0.52	0.51	0.52	0.59	0.50	0.49	0.50	0.69	0.61	0.61	0.61
P12	1.00	0.96	0.75	0.65	0.65	0.64	0.73	0.63	0.63	0.63	0.75	0.65	0.65	0.65
P13	1.00	0.97	0.77	0.69	0.68	0.68	0.75	0.67	0.66	0.66	0.85	0.77	0.77	0.77
P14	1.00	0.97	0.68	0.59	0.59	0.59	0.67	0.58	0.58	0.58	0.81	0.74	0.73	0.73
P15	1.00	0.99	0.62	0.57	0.57	0.56	0.60	0.55	0.55	0.55	0.79	0.75	0.75	0.75
P16	1.00	0.96	0.78	0.68	0.67	0.68	0.78	0.68	0.67	0.68	0.86	0.77	0.76	0.77
P17	1.00	0.94	0.97	0.86	0.85	0.86	0.95	0.83	0.82	0.83	0.97	0.86	0.85	0.86
P18	1.00	0.97	0.86	0.79	0.79	0.79	0.83	0.77	0.76	0.76	0.94	0.88	0.88	0.88
P19	1.00	0.98	0.77	0.70	0.69	0.69	0.77	0.70	0.70	0.70	0.89	0.83	0.82	0.83
P20	1.00	0.98	0.70	0.64	0.65	0.64	0.71	0.65	0.65	0.65	0.88	0.83	0.83	0.83
P21	1.00	0.93	0.84	0.70	0.70	0.70	0.81	0.67	0.66	0.66	0.90	0.76	0.76	0.76
P22	1.00	0.94	1.01	0.88	0.88	0.88	0.98	0.85	0.85	0.85	1.01	0.89	0.89	0.89
P23	1.00	0.98	0.89	0.82	0.82	0.82	0.88	0.81	0.81	0.81	0.92	0.86	0.86	0.86
P24	1.00	0.98	0.64	0.61	0.61	0.61	0.65	0.61	0.62	0.61	0.86	0.84	0.84	0.84
P25	1.00	0.99	0.73	0.70	0.70	0.70	0.72	0.69	0.69	0.69	0.95	0.93	0.93	0.93
AVG	1.00	0.97	0.68	0.61	0.61	0.61	0.67	0.60	0.60	0.60	0.77	0.70	0.70	0.70

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F), five-factor (5F) and *q*-factor (q) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM)*, short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the individual output gap with the global output gap (Atanasov, 2018). Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M).

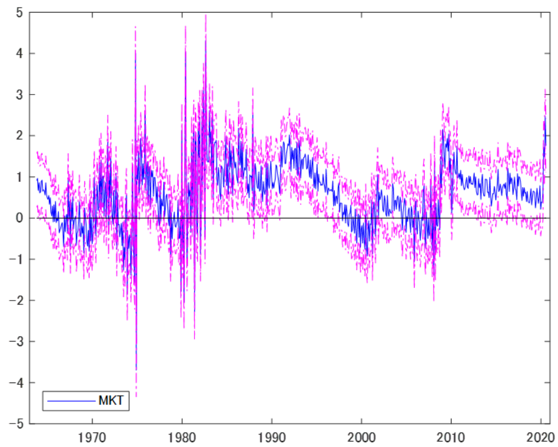
Figure 1 Output gaps for the U.S., Europe and Japan



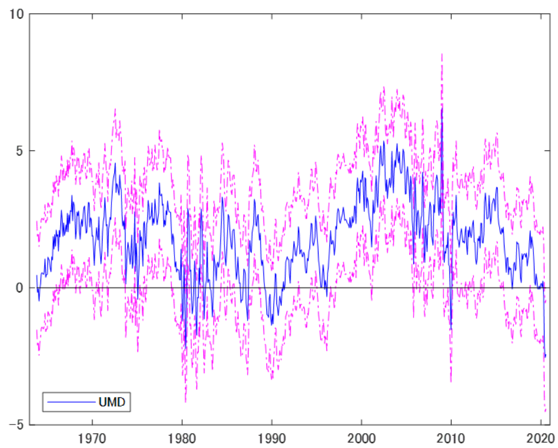
Notes: This figure displays the output gaps for the U.S., Europe and Japan. The output gaps are estimated using Equation (6) and the output gap for European countries is given by the real GDP weighted average.

Figure 2 Time-varying price of market and momentum risks

Panel A: Market risk



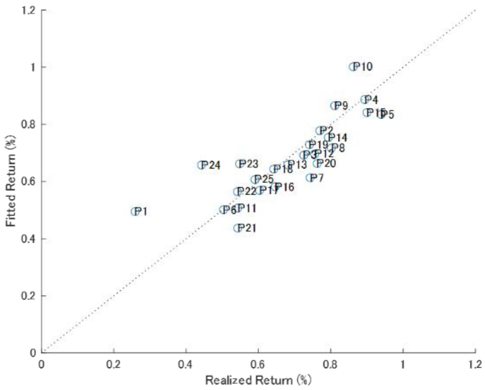
Panel B: Momentum risk



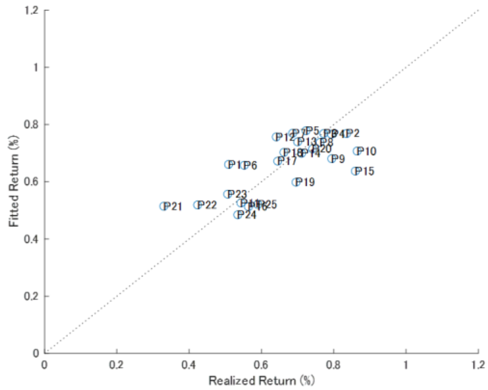
Notes: This figure displays the time-varying price of market risk (*MKT*), $\Lambda_{1,mkt}S_{gap,t}$ and momentum risk (*UMD*), $\Lambda_{1,umd}S_{gap,t}$ with 95% confidence intervals. The price of risk is estimated using Equation (4). The test portfolio is 25 US portfolios sorted by size and book-to-market (Size-B/M).

Figure 3 Comparison of pricing errors

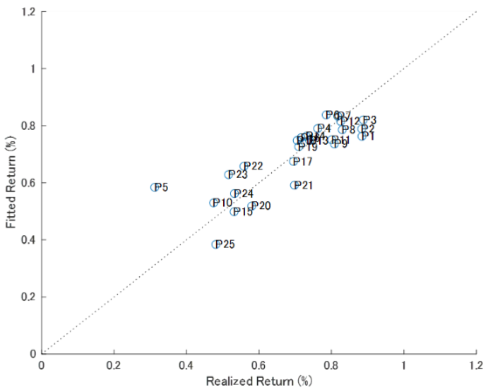
Panel A: Size-B/M



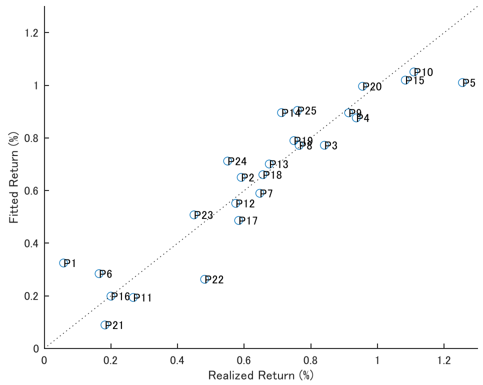
Panel B: Size-OP



Panel C: Size-Inv



Panel D: Size-Mom



Notes: This figure displays the comparison of pricing errors. The realized mean excess returns are on the horizontal axis and the mean fitted excess returns are on the vertical axis. The fitted excess returns are estimated by Equation (4). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*).

Risk price decomposition and the output gap

Ryuta Sakemoto

May 2, 2024

Online Supplement, Not for Publication

A1. Estimation steps of the time-varying price of risk model

Following Adrian et al. (2015), we use stacked vectors and Equation (4) is rewritten as

$$R = B\lambda_0 \iota_T' + B\Lambda_1 S_- + BU_F + E \tag{A1}$$

where $R = [R_1 \cdots R_T]$ is $N \times T$ with $R_t = \left(R_{1,t}, \cdots, R_{N,t}\right)'$ and N indicates the number of test portfolios and N does the time period. The stacked vector of state variables $S_- = [S_0 \cdots S_{T-1}]$ is $k_1 \times \mathrm{T}$, the stacked vector of risk factor innovations $U_F = \left[u_{F,1} \cdots u_{F,T}\right]$ is $k_2 \times \mathrm{T}$ and the stacked vector of error terms $E = [\varepsilon_1 \cdots \varepsilon_T]$ is $N \times T$ with $\varepsilon_t = \left(\varepsilon_{1,t}, \cdots, \varepsilon_{N,t}\right)'$. The estimated parameter $B = [B_1 \cdots B_N]'$ is an $\mathrm{N} \times k_2$ matrix. ι_T is a vector of ones and the estimated parameter vectors, λ_0 is a $k_2 \times 1$ matrix and Λ_1 is a $k_2 \times k_1$ matrix.

We adopt the following three estimation steps. First, we use the VAR model in Equation (2) and obtain risk factor innovations $\widehat{U}_F$. Let $\hat{Z} = \left[\iota_T\ S_-'\ \widehat{U}_F'\right]'$ and Equation (A1) is rewritten as

$$R = A_{ols}\hat{Z} + E. \tag{A2}$$

Second, we run Equation (A2) and obtain the coefficient matrix $\hat{A}_{ols}$. The estimate parameter $\hat{A}_{ols}$ is portioned as: $\hat{A}_{ols} = \left[\hat{A}_{0,ols}\ \hat{A}_{1,ols}\ \hat{B}\right]$ and Adrian et al. (2015) derive the heteroskedasticity-robust variance matrix estimator of $\hat{A}_{ols}$. Using Equations (A1) and (A2), $\hat{A}_{0,ols}$ and $\hat{A}_{1,ols}$ are decomposed as

$$\hat{A}_{0,ols} = \hat{B}\lambda_0, \quad \hat{A}_{1,ols} = \hat{B}\Lambda_1. \tag{A3}$$

Finally, we obtain the parameters λ_0 and Λ_1 by regressing $\hat{A}_{0,ols}$ and $\hat{A}_{1,ols}$ onto $\hat{B}$ using the following regression-based approach

$$\hat{\lambda}_0 = \left(\hat{B}'\hat{B}\right)^{-1}\hat{B}'\hat{A}_{0,ols}, \quad \Lambda_1 = \left(\hat{B}'\hat{B}\right)^{-1}\hat{B}'\hat{A}_{1,ols}. \tag{A4}$$

A2. Different state variables in Europe and Japan

Given the strong impact driven by the output gap after controlling for the different state variables, we repeat the same estimation for European and Japanese portfolios. We adopt the same four state variables in Section 5.1. The European variables are constructed as the real GDP weighted averages, as described in Section 3.2.

Tables A4 and A6 present empirical evidence that *GAP* is still a driving force in generating the time-varying price of *MKT* risk for European portfolios. *UNC* is negatively linked to the price of *MKT* risk, which suggests that an increase in economic uncertainty reduces the price of *MKT* risk. The relationship between economic uncertainty and the price of *MKT* risk is nonlinear, and the high U.S. uncertainty causes a flight-to-quality episode, see Adrian et al. (2019). We also observe a positive link between the prices of *SMB* and *SHO* risks, which indicates that cutting interest rates results in an increase in the size price for European portfolios. Fama and French (2012, 2017) report that the size effects for European portfolios are small. Our results demonstrate that it is sensitive to changes in short-term interest rates. Table A5 and A7 provide the Japanese results and we confirm that the output gap still plays an important role in the time-varying price of *MKT* risk.

A3. Comparison with rolling regressions

Having found the improvement of RMSPE in Table 5, we investigate whether conventional rolling regression approaches generate smaller RMSPEs. We follow Adrian et al. (2015) and employ a rolling regression model proposed by Fama and MacBeth (1973). Moreover, we use a rolling regression model with state variables, similar to Ferson and Harvey (1991). Tables A12-A18 provide RMSPE for each portfolio and include the time-varying price of risk (TVP) and Fama and MacBeth (FMB) models, rolling Fama and MacBeth (RFMB) and Ferson and Harvey (FH) models. We affirm that the time-varying price of risk model is successful in reducing RMSPE for all regions compared with FMB, RFMB and FH.

A.4 100 test portfolios

We employ test portfolios sorted by several characteristics because sorting rules influence results (Liu and Zhang, 2008; Lewellen et al., 2010). We test whether combining the test portfolios influences our estimation results. Tables A27-A29 present empirical evidence that the output gap is negatively related to the price of *MKT* risk for all three regions. Moreover, the output gap has the positive impact on the price of *UMD* risk for the U.S. and European results.

A.5 Different methods of the output-gap estimation

There are several ways for estimating output gaps. We follow Cooper and Priestley (2009) and Colacito et al. (2020) and employ three different estimation methods in this section. The first one is the single time trend specification. We estimate the output gap using Equation (A5) and then implement the time-varying price of risk model.

$$ip_t = a + b \cdot t + e_t. \tag{A5}$$

The second is Hodrick-Prescott's (1997) filter (HP) that decompose trend and cyclical components. We employ the cyclical component of the log of industrial production as the output gap.

The third is the linear projection method proposed by Hamilton (2018). We employ the following specification (Colacito et al., 2020):

$$ip_t = a + \sum_{s=0}^{11} b_s \cdot ip_{t-24-s} + e_t. \tag{A6}$$

We deploy the residuals in Equation (A6) as the output gap.

Table A49 summarises the difference in output gap estimation methods. We find that the output gap is negatively associated with the price of *MKT* risk. Moreover, the output gaps positively impact the price of *UMD* risk for the U.S. portfolios and on the price on *HML* risk for the Japanese portfolios. These results are associated with the weak momentum and strong book-to-market effects in Japan (Fama and French, 2012; 2017). The weak relationship between *UMD* and the output gap in the European portfolios reflects the impact of the output gap on *UMD* is not as strong as that on *MKT*. Moreover, the weak results in Europe indicate that business cycles are not completely synchronised across these countries (Kose et al., 2012).

A6. Effects of time lags

We consider the effects of publication lags. We follow Cooper and Priestley (2009) and adopt the two-month lagged output gap in Equation (4), since the industrial production is published in the middle of month. Tables A30-A32 demonstrate that these changes do not affect the results of the price of market for all three regions. However, the parameter on the price of momentum risk becomes weak in the U.S., which suggests that the price of momentum risk is more sensitive to timing of the output gap publication.

Industrial production data are revised from the original data. We investigate whether these revisions are associated with the results and we adopt the vintage of the industrial production index obtained from the Federal Reserve Bank of Philadelphia. Table A33 presents that the effects of revised data are small, and we can see the same results.

Table A1 Four Factor Model with Different State Variables

			const		*GAP*		*SHO*		*TERM*		*UNC*		mean	
(a)	Size-B/M	*MKT*	2.48	**	-8.96	***	-0.68		0.02		-2.43		0.61	***
			(1.26)		(3.25)		(0.75)		(0.18)		(1.88)		(0.20)	
		SMB	-1.59	*	1.91		0.00		0.18		2.30	*	0.21	
			(0.89)		(2.31)		(0.53)		(0.14)		(1.34)		(0.14)	
		HML	0.27		3.42		1.73	***	0.30	**	-1.61		0.32	**
			(0.85)		(2.13)		(0.49)		(0.12)		(1.29)		(0.14)	
		UMD	-1.97		27.84	**	3.27		2.89	***	-0.62		3.40	***
			(4.64)		(13.64)		(2.75)		(0.91)		(7.33)		(1.03)	
(b)	Size-OP	*MKT*	2.71	**	-9.39	***	-0.69		-0.04		-2.69		0.57	***
			(1.26)		(3.21)		(0.75)		(0.18)		(1.88)		(0.19)	
		SMB	-1.69	*	2.36		-0.48		0.11		2.81	**	0.15	
			(0.89)		(2.25)		(0.53)		(0.13)		(1.34)		(0.14)	
		HML	-1.09		3.12		2.48	***	0.79	***	-0.78		0.56	**
			(1.39)		(4.22)		(0.87)		(0.23)		(2.11)		(0.25)	
		UMD	1.64		11.32		-1.48		0.47		-0.07		1.82	***
			(4.23)		(10.85)		(2.25)		(0.63)		(6.60)		(0.64)	
(c)	Size-INV	*MKT*	2.57	**	-9.19	***	-0.60		0.00		-2.59		0.59	***
			(1.26)		(3.21)		(0.75)		(0.18)		(1.88)		(0.19)	
		SMB	-1.39		1.70		-0.23		0.13		2.15		0.15	
			(0.91)		(2.31)		(0.54)		(0.13)		(1.39)		(0.14)	
		HML	-0.92		3.33		1.51	**	0.36	**	0.54		0.56	***
			(1.04)		(2.74)		(0.61)		(0.15)		(1.59)		(0.17)	
		UMD	6.34		23.91	*	4.57	*	1.23	*	-12.24		2.01	***
			(4.66)		(12.22)		(2.45)		(0.65)		(7.52)		(0.75)	
(d)	Size-MOM	*MKT*	2.63	**	-9.12	***	-0.39		-0.01		-2.78		0.59	***
			(1.27)		(3.25)		(0.76)		(0.18)		(1.90)		(0.19)	
		SMB	-1.82	*	1.31		-0.68		0.08		3.28	**	0.20	
			(0.97)		(2.44)		(0.56)		(0.13)		(1.48)		(0.15)	
		HML	-0.23		2.14		0.89		0.56	**	-0.62		0.57	**
			(1.48)		(4.14)		(0.92)		(0.22)		(2.45)		(0.22)	
		UMD	2.34	*	6.87	**	1.84	**	0.19		-3.94	**	0.76	***
			(1.21)		(3.09)		(0.72)		(0.17)		(1.83)		(0.19)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM)*, short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A2 Five Factor Model with Different State Variables

			const	*GAP*	*SHO*	*TERM*	*UNC*	mean
(a)	Size-B/M	*MKT*	2.62 **	-9.53 ***	-0.82	-0.08	-2.51	0.48 **
			(1.26)	(3.24)	(0.75)	(0.18)	(1.88)	(0.19)
		SMB	-1.81 **	1.85	0.08	0.25 *	2.57 *	0.29 **
			(0.88)	(2.24)	(0.52)	(0.13)	(1.33)	(0.13)
		HML	0.56	2.80	1.67 ***	0.20 *	-1.94	0.23
			(0.85)	(2.11)	(0.49)	(0.12)	(1.28)	(0.14)
		RMW	-1.14	-0.11	0.51	0.33 *	1.22	0.36 *
			(1.26)	(3.50)	(0.73)	(0.20)	(2.02)	(0.19)
		CMA	-0.79	7.75 **	0.62	0.38 **	0.22	0.21
			(1.32)	(3.39)	(0.72)	(0.19)	(2.07)	(0.20)
(b)	Size-OP	*MKT*	2.53 **	-9.45 ***	-0.68	-0.04	-2.46	0.56 ***
			(1.26)	(3.22)	(0.75)	(0.18)	(1.88)	(0.19)
		SMB	-1.70 *	2.48	-0.49	0.11	2.84 **	0.18
			(0.89)	(2.25)	(0.53)	(0.13)	(1.35)	(0.14)
		HML	0.36	0.89	2.61 ***	0.51 ***	-3.10 *	0.09
			(1.16)	(3.03)	(0.71)	(0.18)	(1.75)	(0.20)
		RMW	-0.69	0.95	0.25	0.17 *	0.81	0.21 **
			(0.63)	(1.62)	-(0.77)	(0.09)	(0.95)	(0.09)
		CMA	-0.22	6.04 *	0.02	0.11	0.18	0.11
			(1.35)	(3.66)	(0.90)	(0.20)	(2.16)	(0.21)
(c)	Size-INV	*MKT*	2.51 *	-9.53 ***	-0.77	-0.04	-2.36	0.57 ***
			(1.26)	(3.20)	(0.75)	(0.18)	(1.88)	(0.19)
		SMB	-1.44	1.38	0.14	0.16	1.94	0.14
			(0.94)	(2.32)	(0.56)	(0.13)	(1.44)	(0.13)
		HML	-0.58	8.57 *	0.40	0.55 **	0.34	0.67 ***
			(1.73)	(4.74)	(1.06)	(0.26)	(2.71)	(0.28)
		RMW	0.01	0.66	2.01 **	0.25	-1.83	-0.05
			(1.48)	(4.36)	(0.99)	(0.23)	(2.46)	(0.23)
		CMA	-0.59	0.95	0.68 *	0.03	0.72	0.20 **
			(0.63)	(1.59)	(0.37)	(0.09)	(0.95)	(0.09)
(d)	Size-MOM	*MKT*	2.57 **	-9.38 ***	-0.42	-0.01	-2.65	0.60 ***
			(1.28)	(3.30)	(0.76)	(0.18)	(1.92)	(0.20)
		SMB	-1.19	2.78	-0.21	0.16	2.16	0.41 ***
			(0.99)	(2.53)	(0.58)	(0.14)	(1.52)	(0.16)
		HML	-3.45 *	-4.55	-1.46	0.14	4.96	-0.55
			(1.91)	(5.08)	(1.09)	(0.25)	(3.16)	(0.41)
		RMW	1.77	4.37	1.34	0.18	-3.48	0.28
			(1.82)	(5.12)	(1.11)	(0.26)	(3.02)	(0.44)
		CMA	0.40	3.28	1.27	0.44	-0.99	0.91 ***
			(2.09)	(5.63)	(1.20)	(0.29)	(3.50)	(0.41)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*), as proposed by Fama and French (2015). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A3 *q*-Factor Model with Different State Variables

			const	*GAP*	*SHO*	*TERM*	*UNC*	mean
(a)	Size-B/M	*MKT*	2.74 **	-10.06 ***	-0.79	-0.10	-2.65	0.49 **
			(1.37)	(3.40)	(0.77)	(0.19)	(1.98)	(0.21)
		R_ME	-2.85 ***	3.42	0.21	0.44 ***	3.64 **	0.36 **
			(1.01)	(2.47)	(0.56)	(0.14)	(1.47)	(0.15)
		R_IA	-0.47	4.42 *	1.65 ***	0.39 ***	-0.72	0.32 **
			(0.93)	(2.40)	(0.50)	(0.14)	(1.38)	(0.14)
		R_ROE	-2.52	4.32	0.11	0.63 ***	2.89	0.48 **
			(1.79)	(4.22)	(0.90)	(0.26)	(2.73)	(0.24)
(b)	Size-OP	*MKT*	2.47 *	-9.45 ***	-0.64	-0.02	-2.43	0.55 ***
			(1.37)	(3.36)	(0.77)	(0.19)	(1.98)	(0.20)
		R_ME	-2.55 **	3.07	-0.22	0.27 *	3.65 **	0.23
			(1.00)	(2.48)	(0.57)	(0.14)	(1.46)	(0.16)
		R_IA	0.72	0.89	1.98 ***	0.36 **	-2.92	0.12
			(1.19)	(2.88)	(0.65)	(0.16)	(1.77)	(0.19)
		R_ROE	-1.54	2.00	0.38	0.34 **	1.89	0.42 ***
			(1.33)	(3.12)	(0.70)	(0.17)	(2.10)	(0.16)
(c)	Size-INV	*MKT*	2.42 *	-9.59 ***	-0.74	-0.03	-2.29	0.54 ***
			(1.37)	(3.35)	(0.77)	(0.19)	(1.97)	(0.20)
		R_ME	-2.01 **	3.56	0.47	0.39 ***	2.22	0.28 *
			(1.01)	(2.45)	(0.57)	(0.14)	(1.47)	(0.14)
		R_IA	-0.44	2.55	0.93 ***	0.17 *	0.19	0.32 ***
			(0.67)	(1.69)	(0.39)	(0.10)	(0.99)	(0.10)
		R_ROE	0.05	7.06 *	2.50 ***	0.73 ***	-2.78	0.35
			(1.58)	(4.20)	(0.92)	(0.25)	(2.46)	(0.23)
(d)	Size-MOM	*MKT*	2.37 *	-9.60 ***	-0.51	-0.02	-2.40	0.52 **
			(1.38)	(3.42)	(0.78)	(0.19)	(2.01)	(0.21)
		R_ME	-1.75	3.27	-0.07	0.25	2.77 *	0.47 ***
			(1.09)	(2.66)	(0.60)	(0.15)	(1.61)	(0.16)
		R_IA	-1.26	0.51	0.07	0.36 *	1.16	0.12
			(1.34)	(3.87)	(0.75)	(0.20)	(2.12)	(0.20)
		R_ROE	2.89 **	5.91 *	2.00 ***	0.17	-4.85 **	0.72 ***
			(1.36)	(3.49)	(0.73)	(0.18)	(2.16)	(0.24)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*R_ME*), investment (*R_IV*) and profitability (*R_ROE*), as proposed by Hou et al. (2015). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from January 1967 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A4 Four Factor Model and Different State Variables in Europe

Europe								
			const	*GAP*	*SHO*	*TERM*	*UNC*	mean
(a)	Size-B/M	*MKT*	4.50 **	-1.92 ***	-1.61	0.03	-5.50 *	0.55 *
			(1.86)	(0.70)	(1.12)	(0.16)	(2.81)	(0.29)
		SMB	0.08	-0.35	-1.03 **	0.13 *	0.25	-0.01
			(0.92)	(0.32)	(0.50)	(0.07)	(1.41)	(4.09)
		HML	0.31	0.68 *	1.05 *	0.06	-0.62	0.18
			(1.01)	(0.39)	(0.58)	(0.09)	(1.55)	(4.21)
		UMD	-0.47	3.15 **	-0.43	-0.15	3.19	1.54
			(4.43)	(1.47)	(1.99)	(0.36)	(6.90)	(4.43)
(b)	Size-OP	*MKT*	4.58 **	-1.93 ***	-1.51	0.03	-5.63 **	0.56
			(1.86)	(0.70)	(1.12)	(0.16)	(2.82)	(0.63)
		SMB	0.15	-0.40	-1.15 **	0.14 *	0.30	0.06
			(0.91)	(0.32)	(0.51)	(0.08)	(1.39)	(4.59)
		HML	-0.80	0.21	0.03	-0.18	1.47	0.15
			(1.45)	(0.53)	(0.77)	(0.14)	(2.25)	(1.14)
		UMD	-1.54	0.42	2.38	-0.70	5.66	2.65
			(3.74)	(1.38)	(2.13)	(0.41)	(5.79)	(3.64)
(c)	Size-INV	*MKT*	4.57 **	-1.92 ***	-1.56	0.04	-5.69 **	0.51
			(1.87)	(0.70)	(1.12)	(0.16)	(2.82)	(0.53)
		SMB	0.20	-0.40	-1.13 **	0.14 *	0.17	0.03
			(0.95)	(0.32)	(0.51)	(0.08)	(1.45)	(4.36)
		HML	-1.24	0.94 *	1.01	0.06	2.27	0.47
			(1.60)	(0.57)	(0.76)	(0.13)	(2.49)	(1.10)
		UMD	3.72	1.62	-0.59	0.42	-5.31	0.22
			(5.58)	(1.78)	(2.63)	(0.44)	(8.69)	(2.94)
(d)	Size-MOM	*MKT*	4.38 **	-1.93 ***	-1.27	0.03	-5.52 **	0.50
			(1.86)	(0.70)	(1.13)	(0.16)	(2.81)	(1.30)
		SMB	0.28	-0.43	-0.93 *	0.14 *	0.14	0.14
			(0.97)	(0.33)	(0.52)	(0.08)	(1.49)	(3.65)
		HML	1.95	0.98	-3.50 **	-0.06	-0.64	0.73
			(2.98)	(0.92)	(1.43)	(0.23)	(4.58)	(11.21)
		UMD	3.26 **	0.84	0.02	-0.10	-3.65	0.95
			(1.53)	(0.57)	(0.92)	(0.13)	(2.32)	(4.13)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A5 Four Factor Model and Different State Variables in Japan

Panel B: Japan								
			const	*GAP*	*SHO*	*TERM*	*UNC*	mean
(a)	Size-B/M	*MKT*	3.47 *	-12.29 **	0.07	-0.14	-5.41 *	0.12 *
			(2.10)	(4.82)	(0.19)	(1.76)	(3.25)	(0.28)
		SMB	-0.92	-3.73	-0.01	0.09	1.66	0.15
			(1.26)	(2.87)	(0.11)	(1.08)	(1.94)	(0.18)
		HML	-0.97	2.68	0.00	-0.01	1.90	0.24
			(1.21)	(2.72)	(0.11)	(1.02)	(1.87)	(0.16)
		UMD	4.95	-1.83	-0.29	2.74	-5.96	0.88
			(5.26)	(10.07)	(0.35)	(5.25)	(8.13)	(0.66)
(b)	Size-OP	*MKT*	3.64 *	-12.70 ***	0.08	-0.35	-5.68 *	0.12
			(2.11)	(4.83)	(0.19)	(1.75)	(3.28)	(0.28)
		SMB	-0.74	-4.94 *	-0.04	0.00	1.53	0.23
			(1.27)	(2.94)	(0.11)	(1.08)	(1.96)	(0.18)
		HML	-6.04 *	17.48 ***	0.07	-0.29	8.77 *	-0.42
			(3.11)	(6.61)	(0.19)	(1.96)	(4.97)	(0.35)
		UMD	0.83	1.43	0.04	-1.51	-0.35	0.64
			(6.01)	(11.59)	(0.37)	(4.67)	(9.46)	(0.65)
(c)	Size-INV	*MKT*	3.42	-12.62 ***	0.08	-0.34	-5.39	0.09
			(2.12)	(4.84)	(0.19)	(1.76)	(3.29)	(0.28)
		SMB	-0.88	-4.22	-0.01	-0.09	1.67	0.20
			(1.27)	(2.90)	(0.11)	(1.08)	(1.96)	(0.18)
		HML	-4.25 **	17.09 ***	-0.06	-0.56	6.86 **	0.02
			(2.15)	(4.62)	(0.14)	(1.71)	(3.39)	(0.27)
		UMD	-0.63	8.40	-0.36	1.34	2.11	0.37
			(4.44)	(8.77)	(0.39)	(3.26)	(7.01)	(0.49)
(d)	Size-MOM	*MKT*	3.56 *	-11.75 **	0.04	0.09	-5.60 *	0.06
			(2.10)	(4.83)	(0.19)	(1.78)	(3.27)	(0.28)
		SMB	-1.46	-6.59 **	0.03	0.70	2.63	0.28
			(1.33)	(3.14)	(0.12)	(1.12)	(2.06)	(0.21)
		HML	-3.70	13.58 *	-0.02	-3.63	5.92	0.01
			(2.83)	(6.95)	(0.25)	(3.12)	(4.38)	(0.39)
		UMD	1.16	7.13 *	-0.28 *	2.39 *	-1.27	0.07
			(1.71)	(3.96)	(0.15)	(1.43)	(2.66)	(0.24)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A6 Five Factor Model and Different State Variables in Europe

Europe			const	*GAP*	*SHO*	*TERM*	*UNC*	mean
(a)	Size-B/M	*MKT*	4.54 **	-1.95 ***	-1.59	0.03	-5.59 **	0.53
			(1.85)	(0.70)	(1.12)	(0.16)	(2.79)	(0.40)
		SMB	-0.15	-0.33	-1.12 **	0.12	0.65	-0.01
			(0.96)	(0.32)	(0.50)	(0.07)	(1.48)	(2.85)
		HML	0.53	0.57	1.15 **	0.08	-1.08	0.13
			(1.03)	(0.38)	(0.58)	(0.09)	(1.58)	(3.00)
		RMW	-4.10 **	0.37	-1.81 *	-0.30 **	7.16 **	0.05
			(1.79)	(0.58)	(1.02)	(0.15)	(2.80)	(7.98)
		CMA	2.42	1.10 *	1.81 **	0.21	-3.92	0.37
			(1.60)	(0.57)	(0.92)	(0.13)	(2.50)	(6.03)
(b)	Size-OP	*MKT*	4.66 **	-1.93 ***	-1.54	0.04	-5.83 **	0.52
			(1.84)	(0.70)	(1.12)	(0.16)	(2.79)	(0.60)
		SMB	0.16	-0.38	-1.14 **	0.13	0.32	0.09
			(0.94)	(0.32)	(0.50)	(0.07)	(1.45)	(2.69)
		HML	-2.02	-0.09	0.17	-0.17	3.52	0.27
			(1.49)	(0.56)	(0.80)	(0.13)	(2.31)	(1.73)
		RMW	-0.63	-0.06	0.51	-0.07	1.49	0.44 **
			(0.65)	(0.25)	-(1.53)	(0.06)	(0.99)	(0.20)
		CMA	0.28	0.30	0.61	-0.17	-0.50	0.11
			(1.51)	(0.58)	(0.80)	(0.13)	(2.34)	(1.77)
(c)	Size-INV	*MKT*	4.64 **	-1.95 ***	-1.53	0.04	-5.84 **	0.49
			(1.85)	(0.70)	(1.12)	(0.16)	(2.79)	(0.63)
		SMB	0.60	-0.39	-1.11 **	0.15 *	-0.34	0.11
			(1.12)	(0.35)	(0.53)	(0.08)	(1.72)	(2.22)
		HML	-6.28 *	1.23	0.39	-0.18	9.79 **	0.11
			(3.00)	(1.00)	(1.37)	(0.20)	(4.59)	(5.27)
		RMW	4.62	0.05	-0.05	0.14	-6.16	0.67
			(3.18)	(0.97)	(1.40)	(0.22)	(4.89)	(3.72)
		CMA	-0.39	0.72 ***	0.87 **	0.09	0.42	0.11
			(0.78)	(0.28)	(0.43)	(0.07)	(1.19)	(1.44)
(d)	Size-MOM	*MKT*	4.78 ***	-1.91 ***	-1.30	0.03	-5.94 **	0.62
			(1.85)	(0.70)	(1.13)	(0.16)	(2.78)	(1.15)
		SMB	0.28	-0.34	-1.08 **	0.13 *	0.18	0.13
			(1.09)	(0.34)	(0.52)	(0.08)	(1.63)	(2.48)
		HML	-4.59	-0.01	-1.85	0.10	6.05	-1.15
			(3.23)	(0.89)	(1.15)	(0.18)	(4.49)	(7.84)
		RMW	1.58	0.74	-0.38	-0.12	-1.81	0.35
			(2.03)	(0.62)	(0.83)	(0.12)	(2.83)	(0.73)
		CMA	3.44	0.10	-0.76	0.05	-3.30	1.15
			(3.17)	(0.69)	(1.17)	(0.18)	(4.51)	(0.72)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A7 Five Factor Model and Different State Variables in Japan

Japan			const		*GAP*		*SHO*	*TERM*		*UNC*		mean
(a)	Size-B/M	*MKT*	3.55	*	-12.54	***	0.08	-0.14		-5.57	*	0.11
			(2.12)		(4.82)		(0.19)	(1.78)		(3.28)		(0.28)
		SMB	-1.04		-3.66		-0.02	0.28		1.83		0.12
			(1.28)		(2.88)		(0.11)	(1.10)		(1.98)		(0.18)
		HML	-0.48		1.75		0.00	0.39		1.16		0.25
			(1.23)		(2.77)		(0.10)	(1.02)		(1.91)		(0.16)
		RMW	6.63		-9.34		0.07	1.75		-9.97		0.35
			(4.41)		(9.47)		(0.28)	(5.33)		(6.80)		(0.56)
		CMA	-4.17		7.82		0.15	-5.75	*	6.49		0.08
			(3.03)		(6.58)		(0.21)	(3.40)		(4.63)		(0.40)
(b)	Size-OP	*MKT*	3.62	*	-12.63	***	0.08	-0.37		-5.66	*	0.11
			(2.11)		(4.83)		(0.19)	(1.77)		(3.28)		(0.28)
		SMB	-0.75		-4.32		-0.05	0.25		1.50		0.19
			(1.30)		(3.02)		(0.12)	(1.13)		(2.01)		(0.19)
		HML	-4.94		7.96		0.08	-1.16		7.57		-0.05
			(3.63)		(8.34)		(0.26)	(2.96)		(5.76)		(0.43)
		RMW	1.17		-2.45		-0.01	-0.62		-1.58		0.16
			(0.87)		(2.02)		(0.09)	(0.72)		(1.34)		(0.12)
		CMA	-5.23	**	17.02	***	0.09	-3.28	*	7.58	**	-0.36
			(2.40)		(5.48)		(0.16)	(1.78)		(3.73)		(0.33)
(c)	Size-INV	*MKT*	3.44		-12.96	***	0.09	-0.29		-5.46	*	0.07
			(2.12)		(4.82)		(0.18)	(1.76)		(3.29)		(0.28)
		SMB	-0.93		-3.59		-0.02	0.14		1.78		0.21
			(1.26)		(2.88)		(0.11)	(1.08)		(1.96)		(0.18)
		HML	-2.35		9.85	*	-0.10	-3.74	*	3.83		-0.03
			(2.48)		(5.47)		(0.19)	(1.97)		(3.92)		(0.29)
		RMW	2.15		-2.82		-0.14	0.79		-3.26		-0.05
			(2.34)		(4.66)		(0.14)	(1.77)		(3.72)		(0.26)
		CMA	-1.97	**	7.08	***	0.00	0.43		3.15	**	0.01
			(0.95)		(2.18)		(0.08)	(0.81)		(1.47)		(0.13)
(d)	Size-MOM	*MKT*	3.39		-11.26	**	0.04	-0.02		-5.35		0.05
			(2.12)		(4.82)		(0.19)	(1.82)		(3.28)		(0.28)
		SMB	-1.54		-3.76		-0.05	1.51		2.95		0.33
			(1.41)		(3.23)		(0.13)	(1.44)		(2.18)		(0.21)
		HML	-1.70		-8.75		0.47	-8.14	**	1.63		-0.20
			(3.99)		(9.51)		(0.31)	(4.11)		(6.22)		(0.52)
		RMW	2.57		2.43		-0.22	0.20		-3.57		0.07
			(2.69)		(6.57)		(0.23)	(3.17)		(4.23)		(0.38)
		CMA	-1.63		6.71		-0.12	3.39		3.16		0.26
			(2.94)		(7.45)		(0.24)	(3.45)		(4.56)		(0.40)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A8 Five Factor Model in Europe

Europe			const		GAP		TERM		DEI	UI		mean	
(a)	Size-B/M	*MKT*	0.62	**	-1.89	**	-0.03		0.11	-0.54		0.54	*
			(0.27)		(0.79)		(0.16)		(0.13)	(1.83)		(0.28)	
		SMB	-0.03		-0.45		0.12	*	0.00	0.48		-0.01	
			(0.12)		(0.36)		(0.07)		(0.06)	(0.82)		(0.12)	
		HML	0.16		0.78	*	0.07		0.06	-0.82		0.13	
			(0.14)		(0.43)		(0.08)		(0.06)	(0.94)		(0.15)	
		RMW	-0.12		-0.05		-0.23		0.03	2.85	*	0.04	
			(0.24)		(0.68)		(0.15)		(0.09)	(1.50)		(0.33)	
		CMA	0.50	**	1.64	***	0.17		0.04	-2.85	**	0.37	
			(0.20)		(0.64)		(0.12)		(0.08)	(1.24)		(0.24)	
(b)	Size-OP	*MKT*	0.61	**	-1.84	**	-0.03		0.11	-0.72		0.52	*
			(0.27)		(0.79)		(0.16)		(0.13)	(1.83)		(0.28)	
		SMB	0.08		-0.47		0.14	*	0.00	0.33		0.09	
			(0.12)		(0.36)		(0.07)		(0.06)	(0.83)		(0.13)	
		HML	0.14		-0.58		-0.13		0.08	2.98	***	0.30	
			(0.20)		(0.62)		(0.12)		(0.08)	(1.24)		(0.29)	
		RMW	0.43	***	-0.08		-0.05		0.01	0.28		0.45	***
			(0.09)		(0.29)		-(0.02)		(0.04)	(0.63)		(0.09)	
		CMA	0.17		0.62		-0.17		0.11	-1.15		0.10	
			(0.21)		(0.64)		(0.13)		(0.09)	(1.25)		(0.22)	
(c)	Size-INV	*MKT*	0.58	**	-1.88	**	-0.02		0.11	-0.63		0.49	*
			(0.27)		(0.79)		(0.16)		(0.13)	(1.83)		(0.28)	
		SMB	0.12		-0.44		0.14	*	-0.02	-0.02		0.11	
			(0.13)		(0.39)		(0.08)		(0.06)	(0.86)		(0.15)	
		HML	-0.13		0.68		-0.07		0.23	4.17	**	0.12	
			(0.35)		(1.04)		(0.19)		(0.18)	(2.07)		(0.55)	
		RMW	0.82	**	0.41		0.07		-0.25	-2.61		0.69	*
			(0.37)		(1.01)		(0.21)		(0.20)	(2.10)		(0.40)	
		CMA	0.09		0.77	**	0.09		0.06	0.08		0.11	
			(0.11)		(0.31)		(0.06)		(0.05)	(0.70)		(0.13)	
(d)	Size-MOM	*MKT*	0.71	**	-1.82	**	-0.04		0.10	-0.72		0.62	**
			(0.28)		(0.79)		(0.16)		(0.13)	(1.83)		(0.29)	
		SMB	0.12		-0.44		0.13	*	0.00	0.36		0.14	
			(0.18)		(0.38)		(0.08)		(0.06)	(0.84)		(0.17)	
		HML	-1.30		-0.26		0.16		0.08	1.98		-1.19	
			(0.85)		(0.97)		(0.19)		(0.12)	(1.66)		(0.84)	
		RMW	0.34		0.75		-0.14		0.08	0.12		0.36	
			(0.52)		(0.68)		(0.13)		(0.08)	(1.23)		(0.52)	
		CMA	1.12	**	0.16		0.02		-0.03	-0.47		1.10	**
			(0.52)		(0.72)		(0.18)		(0.10)	(1.51)		(0.51)	

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A9 Five Factor Model in Japan

Japan								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.09	-9.67 **	0.16	0.85	0.04	0.12
			(0.29)	(4.45)	(1.78)	(1.40)	(0.15)	(0.32)
		SMB	0.10	-5.03 *	0.27	0.56	0.02	0.11
			(0.17)	(2.65)	(1.09)	(0.84)	(0.09)	(0.21)
		HML	0.22	2.18	0.30	-0.06	-0.11	0.25
			(0.16)	(2.52)	(1.01)	(0.78)	(0.08)	(0.18)
		RMW	0.44	-2.93	2.09	-2.97	-0.07	0.46
			(0.53)	(7.49)	(5.06)	(2.14)	(0.20)	(0.54)
		CMA	0.07	7.18	-5.84 *	0.35	-0.13	0.08
			(0.39)	(5.76)	(3.36)	(1.79)	(0.17)	(0.41)
(b)	Size-OP	*MKT*	0.08	-9.65 **	-0.10	1.01	0.03	0.11
			(0.29)	(4.47)	(1.77)	(1.39)	(0.15)	(0.31)
		SMB	0.17	-5.92 **	0.26	0.38	0.04	0.18
			(0.18)	(2.80)	(1.14)	(0.89)	(0.09)	(0.22)
		HML	-0.06	5.92	-1.26	1.47	-0.16	-0.03
			(0.43)	(7.84)	(3.00)	(1.98)	(0.19)	(0.43)
		RMW	0.16	-2.34	-0.51	0.91	0.03	0.16
			(0.12)	(1.85)	(0.01)	(0.56)	(0.06)	(0.12)
		CMA	-0.33	16.04 ***	-3.66 **	-1.24	-0.17	-0.34
			(0.29)	(5.29)	(1.80)	(1.46)	(0.16)	(0.41)
(c)	Size-INV	*MKT*	0.04	-9.99 **	0.01	1.01	0.03	0.07
			(0.29)	(4.45)	(1.77)	(1.39)	(0.15)	(0.32)
		SMB	0.19	-4.89 *	0.13	0.58	0.01	0.21
			(0.17)	(2.67)	(1.08)	(0.85)	(0.09)	(0.20)
		HML	0.05	7.58	-4.27 **	-1.04	-0.05	0.03
			(0.29)	(5.45)	(2.04)	(1.21)	(0.14)	(0.32)
		RMW	0.04	-2.66	0.28	-0.80	0.02	0.04
			(0.26)	(4.55)	(1.76)	(1.01)	(0.12)	(0.26)
		CMA	0.03	5.96 ***	0.29	-0.61	-0.03	0.01
			(0.13)	(2.02)	(0.81)	(0.62)	(0.07)	(0.16)
(d)	Size-MOM	*MKT*	0.03	-8.93 **	0.27	0.97	0.05	0.05
			(0.29)	(4.43)	(1.83)	(1.41)	(0.15)	(0.31)
		SMB	0.32 *	-6.30 **	1.52	0.53	0.06	0.33
			(0.19)	(2.95)	(1.43)	(0.97)	(0.11)	(0.24)
		HML	-0.29	-2.68	-8.25 *	1.06	-0.36	-0.16
			(0.53)	(11.13)	(4.23)	(2.22)	(0.28)	(0.57)
		RMW	0.13	2.07	0.08	-0.36	0.00	0.12
			(0.36)	(5.63)	(3.00)	(1.36)	(0.16)	(0.36)
		CMA	0.24	5.35	2.91	-1.10	-0.11	0.26
			(0.40)	(7.37)	(3.30)	(1.93)	(0.19)	(0.41)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*) and investment (*CMA*). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A10 RMSPE Relative to the Constant Price of Risk Model in Europe

Europe

Panel A: 4 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.87	0.89	0.86	0.88	0.91	Small	0.88	0.88	0.86	0.87	0.89
2	0.83	0.83	0.86	0.89	0.92	2	0.90	0.90	0.86	0.85	0.83
3	0.86	0.83	0.90	0.85	0.92	3	0.90	0.84	0.86	0.87	0.83
4	0.85	0.88	0.87	0.89	0.93	4	0.91	0.90	0.87	0.88	0.84
Big	0.87	0.91	0.84	0.90	0.89	Big	0.93	0.87	0.87	0.88	0.90

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.88	0.90	0.87	0.88	0.88	Small	0.85	0.88	0.90	0.91	0.95
2	0.91	0.91	0.87	0.84	0.84	2	0.84	0.90	0.87	0.89	0.90
3	0.88	0.89	0.89	0.86	0.84	3	0.87	0.90	0.91	0.86	0.89
4	0.90	0.90	0.88	0.87	0.86	4	0.90	0.87	0.88	0.88	0.90
Big	0.91	0.91	0.83	0.86	0.90	Big	0.88	0.90	0.88	0.86	0.96

Panel B: 5 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.87	0.89	0.85	0.87	0.90	Small	0.88	0.87	0.85	0.87	0.89
2	0.84	0.84	0.86	0.88	0.91	2	0.89	0.89	0.85	0.82	0.83
3	0.86	0.83	0.89	0.84	0.91	3	0.89	0.82	0.85	0.85	0.82
4	0.85	0.87	0.85	0.87	0.92	4	0.90	0.89	0.85	0.85	0.83
Big	0.88	0.89	0.83	0.89	0.87	Big	0.90	0.84	0.85	0.86	0.89

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.87	0.89	0.87	0.88	0.88	Small	0.88	0.88	0.90	0.92	0.96
2	0.90	0.90	0.86	0.83	0.84	2	0.90	0.90	0.87	0.90	0.93
3	0.87	0.88	0.88	0.85	0.83	3	0.92	0.90	0.90	0.88	0.94
4	0.88	0.88	0.87	0.85	0.84	4	0.94	0.88	0.87	0.90	0.95
Big	0.86	0.89	0.81	0.84	0.88	Big	0.95	0.91	0.86	0.91	0.98

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the constant price of risk model proposed by Fama and MacBeth (1973) for European portfolios. Time-varying price of risk model is estimated using Equation (4), as proposed by Adrian et al. (2015). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. Panel A is the four-factor model and Panel B is the five-factor model. The state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The sample period extends from September 1993 to July 2020.

Table A11 RMSPE Relative to the Constant Price of Risk Model in Japan

Japan

Panel A: 4 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.94	0.93	0.93	0.91	0.90	Small	0.91	0.91	0.90	0.89	0.92
2	0.94	0.91	0.94	0.89	0.89	2	0.93	0.90	0.92	0.90	0.91
3	0.94	0.92	0.93	0.93	0.90	3	0.94	0.96	0.92	0.90	0.91
4	0.93	0.92	0.94	0.94	0.93	4	0.96	0.96	0.94	0.92	0.90
Big	0.96	0.96	0.96	0.98	0.96	Big	0.98	0.97	0.97	0.96	0.97

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.91	0.94	0.93	0.93	0.89	Small	0.88	0.90	0.92	0.93	0.94
2	0.92	0.92	0.90	0.93	0.90	2	0.88	0.92	0.93	0.90	0.91
3	0.94	0.95	0.92	0.92	0.88	3	0.87	0.93	0.95	0.92	0.91
4	0.95	0.96	0.94	0.92	0.91	4	0.89	0.92	0.95	0.93	0.93
Big	1.00	0.98	0.94	0.96	0.95	Big	0.97	0.98	0.97	0.98	1.00

Panel B: 5 factor model

	Low B/M	2	3	4	High B/M		Low OP	2	3	4	High OP
Small	0.94	0.93	0.93	0.91	0.90	Small	0.90	0.91	0.90	0.90	0.91
2	0.94	0.92	0.94	0.89	0.89	2	0.92	0.90	0.92	0.90	0.90
3	0.94	0.92	0.92	0.92	0.89	3	0.93	0.95	0.92	0.89	0.91
4	0.93	0.92	0.94	0.94	0.93	4	0.95	0.96	0.95	0.91	0.90
Big	0.96	0.96	0.96	0.99	0.96	Big	0.97	0.96	0.98	0.96	0.96

	Low Inv	2	3	4	High Inv		Low Mom	2	3	4	High Mom
Small	0.90	0.94	0.94	0.93	0.89	Small	0.92	0.91	0.92	0.94	0.95
2	0.91	0.92	0.90	0.93	0.89	2	0.93	0.93	0.93	0.92	0.94
3	0.92	0.94	0.92	0.92	0.88	3	0.94	0.94	0.95	0.94	0.95
4	0.95	0.95	0.94	0.91	0.91	4	0.95	0.94	0.95	0.94	0.96
Big	0.97	0.97	0.94	0.96	0.94	Big	0.98	0.98	0.96	0.99	1.00

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the constant price of risk model proposed by Fama and MacBeth (1973) for Japanese portfolios. Time-varying price of risk model is estimated using Equation (4), as proposed by Adrian et al. (2015). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. Panel A is the four-factor model and Panel B is the five-factor model. The state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The sample period extends from September 1993 to July 2020.

Table A12 RMSPE Comparison: Four-Factor Model

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	2.63	2.75	4.03	4.19	2.87	3.08	4.49	4.65
P2	1.64	1.82	2.95	3.10	1.87	2.07	3.17	3.37
P3	1.64	1.83	2.92	3.11	1.84	2.02	2.88	3.07
P4	1.71	1.86	3.05	3.25	1.81	1.99	2.71	2.93
P5	2.15	2.34	3.70	3.90	2.28	2.43	3.66	3.91
P6	1.68	1.88	3.19	3.31	2.06	2.34	3.96	4.15
P7	1.53	1.72	2.64	2.75	1.68	1.90	2.94	3.13
P8	1.35	1.58	2.61	2.75	1.52	1.71	2.59	2.75
P9	1.47	1.70	2.79	2.98	1.45	1.66	2.56	2.77
P10	1.61	1.82	3.29	3.51	1.66	1.86	3.36	3.60
P11	1.87	2.04	2.92	3.02	2.27	2.53	3.85	4.02
P12	1.45	1.65	2.44	2.53	1.62	1.89	2.89	3.05
P13	1.39	1.59	2.43	2.53	1.52	1.78	2.59	2.75
P14	1.51	1.70	2.69	2.85	1.57	1.73	2.37	2.56
P15	1.69	1.98	3.25	3.46	1.59	1.72	3.07	3.31
P16	1.80	1.99	2.81	2.92	2.47	2.78	4.06	4.25
P17	1.53	1.75	2.51	2.61	1.69	1.99	3.00	3.16
P18	1.36	1.58	2.41	2.52	1.58	1.81	2.50	2.65
P19	1.53	1.70	2.56	2.70	1.58	1.74	2.37	2.52
P20	1.87	2.11	3.37	3.57	1.69	1.81	2.99	3.21
P21	1.98	2.15	2.70	2.84	2.49	2.75	3.92	4.07
P22	1.31	1.51	2.14	2.27	1.61	1.86	2.78	2.95
P23	1.08	1.29	2.10	2.26	1.47	1.67	2.23	2.36
P24	1.23	1.43	2.28	2.49	1.45	1.62	2.14	2.29
P25	1.66	1.88	2.85	3.07	1.63	1.75	2.61	2.76
AVG	1.63	1.83	2.82	2.98	1.81	2.02	3.03	3.21

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the four-factor model and the state variables are the U.S. output gap (*GAP*), term spread (TERM), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1966 to July 2020.

Table A13 RMSPE Comparison: Five-Factor Model

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	2.63	2.81	4.29	4.54	3.88	4.03	4.78	4.95
P2	2.05	2.19	3.57	3.80	2.11	2.29	3.21	3.40
P3	1.61	1.83	3.04	3.22	1.87	2.05	2.88	3.07
P4	1.62	1.80	2.90	3.04	1.85	2.03	2.73	2.93
P5	1.84	2.04	3.11	3.26	2.53	2.67	3.71	3.94
P6	1.78	1.98	3.56	3.79	3.44	3.62	4.37	4.54
P7	1.48	1.69	2.83	3.03	2.03	2.22	3.05	3.22
P8	1.43	1.65	2.64	2.78	1.48	1.68	2.55	2.70
P9	1.31	1.55	2.55	2.70	1.47	1.68	2.58	2.78
P10	1.51	1.72	2.98	3.09	2.15	2.31	3.50	3.75
P11	1.54	1.81	3.35	3.53	3.74	3.90	4.38	4.52
P12	1.52	1.75	2.75	2.90	2.03	2.24	2.98	3.14
P13	1.53	1.72	2.42	2.56	1.52	1.78	2.60	2.75
P14	1.47	1.69	2.53	2.63	1.51	1.68	2.37	2.53
P15	1.79	1.95	2.92	2.99	2.24	2.34	3.28	3.53
P16	1.60	1.83	3.10	3.26	3.98	4.18	4.70	4.85
P17	1.65	1.88	2.64	2.80	2.24	2.48	3.17	3.32
P18	1.65	1.79	2.58	2.74	1.58	1.81	2.51	2.66
P19	1.67	1.84	2.61	2.72	1.49	1.65	2.34	2.50
P20	2.03	2.21	3.09	3.20	2.42	2.51	3.23	3.43
P21	1.12	1.37	2.32	2.55	3.94	4.11	4.52	4.67
P22	1.35	1.55	2.18	2.35	2.31	2.50	3.03	3.19
P23	1.64	1.78	2.24	2.39	1.47	1.67	2.21	2.34
P24	1.58	1.68	2.66	2.87	1.51	1.67	2.19	2.35
P25	2.42	2.53	3.15	3.32	2.43	2.51	2.97	3.18
AVG	1.67	1.87	2.88	3.04	2.29	2.46	3.19	3.37

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the five-factor model and the state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1966 to July 2020.

Table A14 RMSPE Comparison: *q*-Factor Model

	Size-B/M				Size-MOM			
	(a) TVP	(b) FMB	(c) FMBR	(d) FH	(m) TVP	(n) FMB	(o) FMBR	(p) FH
P1	2.96	3.13	4.40	4.57	3.47	3.66	4.65	4.77
P2	2.17	2.32	3.62	3.77	2.21	2.40	3.24	3.36
P3	1.67	1.90	3.04	3.14	2.07	2.25	2.94	3.06
P4	1.72	1.91	2.94	3.04	1.94	2.12	2.80	2.94
P5	2.14	2.33	3.26	3.35	2.62	2.76	3.79	4.01
P6	2.13	2.31	3.68	3.83	3.13	3.32	4.33	4.48
P7	1.60	1.80	2.90	3.02	2.20	2.38	3.13	3.25
P8	1.63	1.84	2.70	2.77	1.72	1.89	2.67	2.77
P9	1.64	1.85	2.66	2.76	1.59	1.80	2.66	2.81
P10	2.02	2.19	3.20	3.29	2.16	2.31	3.53	3.77
P11	1.87	2.11	3.43	3.56	3.49	3.67	4.38	4.50
P12	1.56	1.80	2.79	2.89	2.21	2.42	3.11	3.23
P13	1.76	1.93	2.52	2.61	1.77	2.02	2.70	2.80
P14	1.86	2.06	2.70	2.76	1.66	1.82	2.44	2.56
P15	2.42	2.55	3.18	3.22	2.20	2.31	3.29	3.54
P16	1.80	2.02	3.18	3.34	3.80	4.02	4.69	4.90
P17	1.71	1.92	2.68	2.81	2.38	2.61	3.27	3.40
P18	1.90	2.03	2.71	2.83	1.84	2.04	2.59	2.71
P19	1.97	2.12	2.75	2.84	1.61	1.76	2.46	2.58
P20	2.59	2.73	3.33	3.42	2.31	2.40	3.23	3.46
P21	1.29	1.52	2.41	2.62	3.87	4.05	4.57	4.71
P22	1.41	1.60	2.22	2.39	2.40	2.57	3.08	3.24
P23	1.74	1.85	2.36	2.49	1.59	1.77	2.30	2.43
P24	2.15	2.21	2.89	3.08	1.45	1.61	2.21	2.35
P25	3.28	3.36	3.54	3.68	2.33	2.41	2.92	3.13
AVG	1.96	2.14	3.00	3.12	2.32	2.50	3.24	3.39

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the *q*-factor model and the state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from January 1967 to July 2020.

Table A15 RMSPE Comparison: Four-Factor Model and Europe

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	2.15	2.46	3.49	3.69	2.20	2.57	3.98	4.16
P2	1.87	2.11	3.09	3.31	1.72	1.95	2.86	3.03
P3	1.67	1.94	2.93	3.12	1.56	1.73	2.59	2.75
P4	1.52	1.73	2.79	2.94	1.55	1.70	2.59	2.72
P5	1.61	1.77	2.82	2.95	2.28	2.39	3.25	3.37
P6	1.87	2.24	3.28	3.55	1.99	2.35	3.78	3.99
P7	1.58	1.91	3.09	3.32	1.75	1.96	2.99	3.18
P8	1.41	1.64	2.73	2.93	1.57	1.80	2.78	2.94
P9	1.57	1.77	2.86	3.03	1.48	1.67	2.67	2.84
P10	1.59	1.73	2.89	3.05	1.82	2.02	3.18	3.36
P11	1.90	2.22	3.45	3.67	1.86	2.14	3.67	3.86
P12	1.48	1.79	2.88	3.09	1.63	1.81	2.83	3.04
P13	1.55	1.72	2.72	2.87	1.57	1.72	2.65	2.86
P14	1.49	1.75	2.80	2.99	1.39	1.61	2.61	2.79
P15	1.55	1.70	2.92	3.10	1.69	1.89	3.02	3.22
P16	1.64	1.93	3.08	3.26	2.12	2.34	3.66	3.88
P17	1.60	1.81	2.75	2.93	1.50	1.72	2.79	3.01
P18	1.43	1.64	2.62	2.78	1.49	1.70	2.52	2.71
P19	1.46	1.64	2.73	2.93	1.44	1.65	2.71	2.86
P20	1.60	1.72	3.12	3.25	1.58	1.77	2.97	3.12
P21	1.32	1.52	2.49	2.66	1.74	1.98	3.62	3.85
P22	1.36	1.49	2.34	2.50	1.64	1.82	2.68	2.86
P23	1.23	1.46	2.62	2.76	1.24	1.41	2.38	2.51
P24	1.43	1.59	2.74	2.87	1.19	1.39	2.43	2.58
P25	1.67	1.87	3.35	3.55	1.86	1.94	2.91	3.10
AVG	1.58	1.81	2.90	3.08	1.67	1.88	2.97	3.14

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the four-factor model and the state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1993 to July 2020.

Table A16 RMSPE Comparison: Four-Factor Model and Japan

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	3.30	3.50	4.67	5.00	2.46	2.81	3.78	4.07
P2	2.49	2.69	3.62	3.93	1.95	2.16	2.84	3.17
P3	2.45	2.64	3.35	3.70	1.74	1.90	2.74	3.07
P4	1.77	1.95	2.93	3.20	1.86	2.01	2.87	3.15
P5	1.64	1.82	2.79	3.08	2.90	3.09	4.04	4.27
P6	3.13	3.32	4.13	4.42	2.20	2.49	3.65	3.88
P7	1.85	2.02	3.17	3.35	1.60	1.75	2.57	2.76
P8	1.98	2.12	2.98	3.16	1.68	1.81	2.59	2.81
P9	1.57	1.76	2.73	2.97	1.60	1.77	2.84	3.05
P10	1.39	1.55	2.60	2.84	2.07	2.27	3.36	3.56
P11	2.60	2.76	4.00	4.17	1.94	2.23	3.49	3.70
P12	2.02	2.20	3.15	3.34	1.73	1.86	2.74	2.92
P13	1.72	1.85	2.78	2.95	1.66	1.74	2.60	2.77
P14	1.50	1.62	2.50	2.69	1.60	1.73	2.63	2.82
P15	1.40	1.56	2.62	2.81	2.02	2.22	3.37	3.55
P16	2.33	2.49	3.44	3.66	2.01	2.27	3.36	3.54
P17	1.82	1.98	2.69	2.86	1.62	1.76	2.63	2.78
P18	1.76	1.88	2.51	2.65	1.73	1.83	2.51	2.67
P19	1.58	1.69	2.46	2.59	1.69	1.81	2.60	2.72
P20	1.59	1.70	2.72	2.83	2.03	2.19	3.11	3.26
P21	1.64	1.72	2.76	2.88	2.29	2.36	3.44	3.62
P22	1.76	1.82	2.45	2.56	1.87	1.91	2.67	2.80
P23	1.78	1.85	2.61	2.79	1.80	1.87	2.65	2.77
P24	1.70	1.73	2.40	2.47	1.68	1.71	2.46	2.56
P25	2.61	2.71	3.47	3.66	1.85	1.85	2.82	2.91
AVG	1.97	2.12	3.02	3.22	1.90	2.06	2.97	3.17

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the four-factor model and the state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1993 to July 2020.

Table A17 RMSPE Comparison: Five-Factor Model and Europe

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	2.13	2.45	3.41	3.58	2.55	2.89	4.20	4.41
P2	1.88	2.11	3.07	3.28	1.72	1.96	2.90	3.07
P3	1.61	1.89	2.88	3.05	1.54	1.71	2.61	2.78
P4	1.47	1.69	2.81	2.94	1.61	1.75	2.61	2.77
P5	1.54	1.71	2.83	2.97	2.52	2.62	3.15	3.33
P6	1.92	2.29	3.25	3.51	2.65	2.95	4.17	4.35
P7	1.64	1.96	3.14	3.37	1.76	1.96	3.03	3.24
P8	1.39	1.63	2.75	2.95	1.51	1.74	2.72	2.91
P9	1.49	1.69	2.86	3.05	1.57	1.74	2.66	2.86
P10	1.50	1.64	2.85	3.04	2.24	2.40	3.13	3.42
P11	1.90	2.22	3.40	3.64	2.53	2.75	4.08	4.21
P12	1.47	1.78	2.86	3.09	1.63	1.80	2.86	3.09
P13	1.46	1.63	2.71	2.89	1.48	1.64	2.65	2.84
P14	1.38	1.65	2.72	2.91	1.51	1.70	2.63	2.84
P15	1.45	1.59	2.90	3.09	2.31	2.45	3.12	3.37
P16	1.62	1.91	2.99	3.18	2.88	3.06	4.10	4.29
P17	1.51	1.73	2.72	2.91	1.57	1.79	2.85	3.05
P18	1.28	1.51	2.57	2.73	1.39	1.60	2.49	2.68
P19	1.36	1.56	2.72	2.93	1.61	1.79	2.69	2.87
P20	1.50	1.63	3.09	3.25	2.33	2.45	3.14	3.34
P21	1.37	1.56	2.47	2.67	2.98	3.15	4.19	4.45
P22	1.19	1.34	2.36	2.52	1.78	1.95	2.80	3.00
P23	1.14	1.37	2.60	2.72	1.12	1.30	2.34	2.49
P24	1.35	1.50	2.78	2.90	1.60	1.75	2.59	2.72
P25	1.47	1.70	3.26	3.50	2.79	2.83	3.19	3.33
AVG	1.52	1.75	2.88	3.07	1.97	2.15	3.08	3.27

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the five-factor model and the state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1993 to July 2020.

Table A18 RMSPE Comparison: Five-Factor Model and Japan

	Size-B/M				Size-MOM			
	(a)	(b)	(c)	(d)	(m)	(n)	(o)	(p)
	TVP	FMB	FMBR	FH	TVP	FMB	FMBR	FH
P1	3.33	3.53	4.69	5.00	3.08	3.36	3.99	4.23
P2	2.53	2.72	3.64	3.93	2.05	2.26	2.90	3.18
P3	2.49	2.69	3.34	3.68	1.76	1.91	2.75	3.06
P4	1.77	1.95	2.96	3.24	2.01	2.14	2.92	3.23
P5	1.64	1.82	2.79	3.07	3.09	3.26	4.10	4.39
P6	3.10	3.29	4.07	4.34	3.05	3.28	3.86	4.06
P7	1.86	2.04	3.16	3.33	1.72	1.85	2.58	2.74
P8	1.99	2.13	2.93	3.13	1.66	1.78	2.59	2.82
P9	1.53	1.73	2.73	2.96	1.76	1.91	2.87	3.13
P10	1.34	1.52	2.59	2.82	2.56	2.71	3.56	3.81
P11	2.62	2.78	3.89	4.09	2.95	3.15	3.71	3.85
P12	2.02	2.20	3.13	3.31	1.90	2.01	2.74	2.89
P13	1.69	1.83	2.71	2.90	1.65	1.73	2.59	2.75
P14	1.48	1.60	2.43	2.59	1.77	1.88	2.73	2.95
P15	1.37	1.53	2.61	2.81	2.75	2.89	3.68	3.91
P16	2.32	2.49	3.42	3.67	3.13	3.31	3.74	3.85
P17	1.77	1.93	2.69	2.85	1.92	2.04	2.68	2.81
P18	1.71	1.83	2.56	2.69	1.72	1.82	2.52	2.70
P19	1.56	1.67	2.39	2.53	1.80	1.91	2.68	2.83
P20	1.57	1.68	2.71	2.82	2.78	2.88	3.44	3.61
P21	1.65	1.73	2.79	2.93	3.68	3.74	4.12	4.25
P22	1.72	1.79	2.50	2.60	2.22	2.27	2.74	2.86
P23	1.80	1.87	2.58	2.73	1.79	1.86	2.60	2.73
P24	1.72	1.74	2.35	2.42	1.93	1.96	2.61	2.72
P25	2.59	2.71	3.42	3.65	3.03	3.02	3.45	3.54
AVG	1.97	2.11	3.00	3.20	2.31	2.44	3.13	3.32

Notes: This table presents the root mean squared pricing error (RMSPE) across four models. TVP is the time-varying price of risk model (Adrian, et al. 2015), FMB is the Fama and MacBeth model, FMB is the rolling Fama and MacBeth model using the window size is 36 months and FH is the Ferson and Harvey (1991) model using the window size is 36 months. We employ the five-factor model and the state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), and size and momentum (Size-Mom). The sample period extends from September 1993 to July 2020.

Table A19 Single Time Trend Output-Gap: US

			const	GAP	TERM	DEI	UI	mean
(a)	Size-B/M	MKT	0.31	-4.21 **	0.24 *	-0.72 ***	0.11	0.61
			(0.28)	(2.05)	(0.14)	(0.27)	(0.32)	(0.74)
		SMB	0.03	0.53	0.11	-0.21	-0.14	0.21
			(0.20)	(1.47)	(0.11)	(0.19)	(0.22)	(0.14)
		HML	0.07	3.47 **	0.13	0.21	0.20	0.32
			(0.19)	(1.36)	(0.10)	(0.18)	(0.21)	(0.51)
		UMD	0.10	14.59 *	1.97 ***	-0.32	0.60	3.36 **
			(1.02)	(8.36)	(0.68)	(0.96)	(1.07)	(1.71)
(b)	Size-OP	MKT	0.36 *	-4.75 **	0.18	-0.75 ***	0.12	0.57 *
			(0.28)	(2.03)	(0.14)	(0.27)	(0.31)	(0.80)
		SMB	0.05	0.59	0.07	-0.12	-0.13	0.16
			(0.20)	(1.44)	(0.10)	(0.19)	(0.22)	(0.14)
		HML	-0.44	5.46 *	0.59 ***	0.18	0.04	0.55
			(0.32)	(2.87)	(0.17)	(0.32)	(0.35)	(0.65)
		UMD	1.41	-0.60	0.21	0.63	0.60	1.73 ***
			(0.97)	(7.03)	(0.52)	(0.91)	(0.95)	(0.59)
(c)	Size-INV	MKT	0.32	-4.36 **	0.22	-0.78 ***	0.09	0.59
			(0.28)	(2.02)	(0.14)	(0.27)	(0.31)	(0.76)
		SMB	0.00	0.43	0.09	-0.10	-0.17	0.15
			(0.20)	(1.48)	(0.10)	(0.19)	(0.22)	(0.13)
		HML	0.23	3.80 **	0.19 *	0.11	0.24	0.59
			(0.23)	(1.71)	(0.12)	(0.22)	(0.25)	(0.54)
		UMD	0.82	12.37 *	0.53	-0.21	-1.02	1.83
			(0.88)	(7.24)	(0.48)	(0.92)	(1.03)	(1.66)
(d)	Size-MOM	MKT	0.34	-3.92 **	0.20	-0.72 ***	0.09	0.59
			(0.28)	(2.06)	(0.14)	(0.27)	(0.32)	(0.69)
		SMB	0.10	0.10	0.07	-0.15	-0.19	0.21
			(0.21)	(1.57)	(0.11)	(0.20)	(0.23)	(0.14)
		HML	-0.02	-0.26	0.41 **	0.00	0.51	0.60 **
			(0.33)	(2.77)	(0.17)	(0.28)	(0.32)	(0.28)
		UMD	0.78 ***	4.07 **	-0.05	0.35	0.27	0.76
			(0.27)	(1.97)	(0.14)	(0.26)	(0.30)	(0.66)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using Equation (A5). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A20 Single Time Trend Output-Gap: Europe

Europe			const	GAP	TERM	DEI	UI	mean
			const	GAP	TERM	DEI	UI	mean
(a)	Size-B/M	MKT	0.77 ***	-0.64	0.00	0.14	-2.17	0.55 *
			(0.28)	(0.45)	(0.16)	(0.13)	(1.65)	(0.29)
		SMB	0.01	-0.26	0.14 *	0.00	0.01	-0.02
			(0.12)	(0.21)	(0.07)	(0.06)	(0.72)	(0.14)
		HML	0.09	0.86 ***	0.05	0.06	-0.25	0.18
			(0.14)	(0.24)	(0.08)	(0.06)	(0.83)	(0.28)
		UMD	1.37 **	1.96 *	-0.15	0.18	-0.83	1.55 *
			(0.61)	(1.06)	(0.38)	(0.19)	(2.58)	(0.80)
(b)	Size-OP	MKT	0.79 **	-0.63	0.00	0.13	-2.22	0.57 *
			(0.28)	(0.45)	(0.16)	(0.13)	(1.66)	(0.29)
		SMB	0.10	-0.26	0.15 **	0.01	-0.04	0.06
			(0.13)	(0.20)	(0.07)	(0.06)	(0.73)	(0.14)
		HML	0.02	0.12	-0.14	0.07	1.45	0.12
			(0.23)	(0.34)	(0.13)	(0.09)	(1.06)	(0.28)
		UMD	2.44 ***	0.69	-0.61	0.19	1.03	2.57 ***
			(0.72)	(0.94)	(0.39)	(0.22)	(2.75)	(0.78)
(c)	Size-INV	MKT	0.73 **	-0.63	0.01	0.13	-2.18	0.51 *
			(0.28)	(0.45)	(0.16)	(0.13)	(1.66)	(0.29)
		SMB	0.07	-0.26	0.14 *	0.00	-0.19	0.03
			(0.12)	(0.21)	(0.08)	(0.06)	(0.73)	(0.14)
		HML	0.27	0.81 **	0.08	0.13 *	1.79 *	0.48
			(0.19)	(0.37)	(0.13)	(0.08)	(1.08)	(0.37)
		UMD	0.28	1.21	0.38	-0.11	-2.42	0.29
			(0.64)	(1.22)	(0.46)	(0.24)	(3.62)	(0.72)
(d)	Size-MOM	MKT	0.72 ***	-0.58	0.00	0.13	-2.26	0.51 *
			(0.28)	(0.45)	(0.16)	(0.13)	(1.66)	(0.29)
		SMB	0.17	-0.24	0.15 *	-0.01	-0.15	0.14
			(0.13)	(0.21)	(0.08)	(0.06)	(0.75)	(0.15)
		HML	0.59 *	-0.18	-0.08	0.20 *	2.29	0.69 *
			(0.34)	(0.58)	(0.23)	(0.13)	(1.63)	(0.40)
		UMD	0.90 ***	0.32	-0.16	0.01	0.25	0.95 ***
			(0.23)	(0.36)	(0.13)	(0.10)	(1.33)	(0.22)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*). term spread (TERM), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using Equation (A5). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A21 Single Time Trend Output-Gap: Japan

Japan									
			const	GAP	TERM	DEI	UI	mean
(a)	Size-B/M	MKT	0.20	-5.09 **	0.11	1.00	-0.12	0.12
			(0.29)	(2.39)	(1.77)	(1.39)	(0.14)	(0.72)
		SMB	0.18	-2.45 *	0.08	0.44	-0.06	0.15
			(0.18)	(1.44)	(1.07)	(0.84)	(0.09)	(0.39)
		HML	0.12	4.04 ***	-0.15	-0.03	-0.04	0.24
			(0.16)	(1.33)	(1.00)	(0.77)	(0.08)	(0.69)
		UMD	0.70	3.17	2.01	0.18	-0.15	0.83
			(0.63)	(5.13)	(5.16)	(2.76)	(0.27)	(0.91)
(b)	Size-OP	MKT	0.20	-5.16 **	-0.08	1.00	-0.13	0.13
			(0.29)	(2.39)	(1.76)	(1.39)	(0.14)	(0.72)
		SMB	0.28	-3.28 **	0.03	0.86	-0.06	0.23
			(0.18)	(1.48)	(1.09)	(0.86)	(0.09)	(0.50)
		HML	-0.58	7.80 ***	-0.69	-2.81 *	0.02	-0.41
			(0.31)	(2.98)	(2.02)	(1.55)	(0.18)	(1.22)
		UMD	0.52	4.55	-1.42	-2.02	-0.19	0.68
			(0.63)	(5.90)	(4.62)	(3.15)	(0.30)	(1.06)
(c)	Size-INV	MKT	0.17	-5.36 **	-0.10	0.96	-0.13	0.09
			(0.29)	(2.40)	(1.76)	(1.40)	(0.15)	(0.76)
		SMB	0.24	-2.52 *	-0.06	0.70	-0.07	0.20
			(0.17)	(1.45)	(1.07)	(0.86)	(0.09)	(0.39)
		HML	-0.10	7.33 ***	-0.95	-1.55	0.16	0.02
			(0.24)	(2.08)	(1.84)	(1.15)	(0.12)	(1.04)
		UMD	0.29	4.55	0.63	-2.00	0.13	0.35
			(0.50)	(4.65)	(3.37)	(2.28)	(0.26)	(0.77)
(d)	Size-MOM	MKT	0.14	-4.90 **	0.33	0.91	-0.10	0.06
			(0.29)	(2.40)	(1.78)	(1.40)	(0.15)	(0.70)
		SMB	0.33	-3.30 **	0.76	0.66	-0.06	0.28
			(0.19)	(1.57)	(1.13)	(0.91)	(0.09)	(0.51)
		HML	-0.08	2.48	-3.68	0.87	-0.09	0.01
			(0.37)	(3.52)	(3.15)	(1.81)	(0.20)	(0.58)
		UMD	0.08	2.08	2.24	-0.48	0.17	0.08
			(0.24)	(1.97)	(1.44)	(1.13)	(0.12)	(0.31)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using Equation (A5). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A22 RMSPE Comparison: Factors, Time-variation and State Variables: US. and Size-MOM

	US: Size-Mom													
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP-G	5F	5F-TVP1	5F-TVP2	5F-TVP-G	q	q-TVP1	q-TVP2	q-TVP-G
P1	1.00	0.99	0.57	0.53	0.70	0.52	0.75	0.72	0.52	0.71	0.68	0.63	0.64	0.64
P2	1.00	0.98	0.57	0.51	0.57	0.50	0.63	0.58	0.51	0.57	0.66	0.60	0.61	0.60
P3	1.00	0.99	0.60	0.55	0.56	0.54	0.61	0.56	0.55	0.55	0.67	0.62	0.62	0.61
P4	1.00	0.99	0.61	0.55	0.56	0.54	0.62	0.56	0.55	0.55	0.64	0.59	0.59	0.58
P5	1.00	0.99	0.59	0.55	0.61	0.54	0.64	0.61	0.55	0.60	0.67	0.63	0.63	0.63
P6	1.00	0.98	0.51	0.45	0.72	0.44	0.78	0.75	0.44	0.74	0.72	0.67	0.68	0.67
P7	1.00	0.98	0.59	0.52	0.62	0.51	0.69	0.63	0.52	0.63	0.74	0.68	0.68	0.68
P8	1.00	0.98	0.63	0.56	0.54	0.56	0.62	0.55	0.56	0.54	0.70	0.63	0.64	0.63
P9	1.00	0.98	0.59	0.52	0.52	0.51	0.60	0.53	0.52	0.52	0.64	0.57	0.57	0.56
P10	1.00	0.99	0.52	0.46	0.59	0.46	0.64	0.60	0.46	0.60	0.64	0.60	0.60	0.60
P11	1.00	0.98	0.58	0.52	0.84	0.51	0.89	0.85	0.51	0.85	0.84	0.79	0.79	0.79
P12	1.00	0.97	0.69	0.59	0.73	0.59	0.82	0.74	0.59	0.74	0.89	0.80	0.81	0.80
P13	1.00	0.96	0.74	0.63	0.62	0.63	0.74	0.63	0.63	0.63	0.84	0.73	0.74	0.74
P14	1.00	0.96	0.75	0.68	0.65	0.67	0.73	0.65	0.67	0.65	0.79	0.72	0.72	0.72
P15	1.00	0.99	0.54	0.50	0.70	0.50	0.74	0.71	0.50	0.70	0.73	0.69	0.69	0.69
P16	1.00	0.97	0.62	0.55	0.88	0.55	0.94	0.89	0.55	0.89	0.90	0.85	0.85	0.85
P17	1.00	0.96	0.76	0.64	0.84	0.64	0.94	0.85	0.64	0.85	0.99	0.90	0.91	0.90
P18	1.00	0.95	0.87	0.76	0.75	0.76	0.87	0.76	0.75	0.76	0.99	0.88	0.89	0.88
P19	1.00	0.96	0.94	0.85	0.81	0.85	0.89	0.80	0.85	0.80	0.95	0.86	0.87	0.87
P20	1.00	0.99	0.63	0.58	0.83	0.58	0.87	0.84	0.59	0.84	0.83	0.80	0.80	0.80
P21	1.00	0.98	0.65	0.59	0.94	0.59	0.97	0.93	0.59	0.93	0.96	0.92	0.92	0.91
P22	1.00	0.96	0.71	0.61	0.88	0.61	0.95	0.88	0.61	0.88	0.98	0.91	0.91	0.91
P23	1.00	0.94	0.93	0.82	0.81	0.82	0.93	0.82	0.82	0.82	0.98	0.88	0.88	0.88
P24	1.00	0.96	0.91	0.82	0.86	0.82	0.95	0.85	0.82	0.85	0.91	0.82	0.82	0.82
P25	1.00	0.99	0.68	0.63	0.94	0.63	0.97	0.94	0.64	0.94	0.93	0.91	0.90	0.90
AVG	1.00	0.97	0.67	0.60	0.72	0.59	0.79	0.73	0.60	0.73	0.81	0.75	0.75	0.75

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F), five-factor (5F) and *q*-factor (q) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM)*, short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the U.S. output gap with the global output gap (Atanasov, 2018). Test assets are 25 US portfolios sorted by size and momentum (Size-MOM).

Table A23 RMSPE Comparison: Factors, Time-variation and State variables: Europe and Size-B/M

Europe: Size-B/M										
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP1-G	5F	5F-TVP1	5F-TVP2	5F-TVP1-G
P1	1.00	0.93	0.74	0.65	0.62	0.66	0.73	0.64	0.61	0.66
P2	1.00	0.92	0.74	0.65	0.62	0.67	0.74	0.65	0.61	0.67
P3	1.00	0.91	0.75	0.65	0.62	0.66	0.73	0.62	0.59	0.64
P4	1.00	0.92	0.72	0.63	0.61	0.64	0.70	0.61	0.58	0.62
P5	1.00	0.94	0.70	0.64	0.62	0.64	0.68	0.61	0.58	0.61
P6	1.00	0.91	0.71	0.59	0.57	0.62	0.73	0.61	0.58	0.63
P7	1.00	0.89	0.76	0.63	0.60	0.65	0.78	0.65	0.62	0.67
P8	1.00	0.92	0.69	0.59	0.57	0.60	0.68	0.58	0.55	0.60
P9	1.00	0.93	0.73	0.65	0.63	0.65	0.69	0.61	0.59	0.62
P10	1.00	0.96	0.66	0.61	0.60	0.61	0.63	0.57	0.55	0.58
P11	1.00	0.91	0.74	0.63	0.61	0.66	0.74	0.63	0.60	0.66
P12	1.00	0.88	0.79	0.66	0.63	0.68	0.79	0.65	0.62	0.68
P13	1.00	0.93	0.82	0.74	0.73	0.75	0.78	0.69	0.67	0.70
P14	1.00	0.90	0.80	0.68	0.68	0.69	0.75	0.63	0.61	0.64
P15	1.00	0.96	0.71	0.65	0.65	0.66	0.67	0.61	0.59	0.61
P16	1.00	0.88	0.85	0.72	0.70	0.74	0.84	0.71	0.68	0.73
P17	1.00	0.88	0.96	0.85	0.85	0.87	0.92	0.81	0.79	0.82
P18	1.00	0.88	0.97	0.84	0.84	0.86	0.90	0.76	0.74	0.78
P19	1.00	0.92	0.85	0.76	0.76	0.76	0.81	0.71	0.70	0.71
P20	1.00	0.97	0.72	0.67	0.66	0.67	0.68	0.63	0.61	0.63
P21	1.00	0.92	0.73	0.64	0.64	0.65	0.75	0.66	0.65	0.68
P22	1.00	0.93	1.04	0.95	0.96	0.96	0.93	0.83	0.82	0.85
P23	1.00	0.87	1.08	0.91	0.92	0.93	1.02	0.84	0.83	0.86
P24	1.00	0.96	0.98	0.88	0.89	0.89	0.93	0.83	0.82	0.84
P25	1.00	0.95	0.73	0.65	0.66	0.66	0.67	0.58	0.56	0.58
AVG	1.00	0.92	0.80	0.70	0.69	0.71	0.77	0.67	0.65	0.68

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F) and five-factor (5F) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM)*, short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the individual output gap with the global output gap (Atanasov, 2018). Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M).

Table A24 RMSPE Comparison: Factors, Time-variation and State variables: Europe and Size-MOM

	Europe: Size-Mom									
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP1-G	5F	5F-TVP1	5F-TVP2	5F-TVP1-G
P1	1.00	0.92	0.71	0.60	0.59	0.62	0.80	0.70	0.68	0.71
P2	1.00	0.91	0.81	0.71	0.70	0.72	0.81	0.71	0.69	0.72
P3	1.00	0.93	0.76	0.69	0.66	0.70	0.75	0.68	0.64	0.69
P4	1.00	0.95	0.71	0.65	0.63	0.66	0.73	0.67	0.64	0.68
P5	1.00	0.97	0.69	0.66	0.64	0.67	0.76	0.73	0.71	0.74
P6	1.00	0.93	0.65	0.55	0.55	0.56	0.82	0.74	0.72	0.74
P7	1.00	0.92	0.79	0.71	0.69	0.72	0.79	0.71	0.68	0.72
P8	1.00	0.91	0.78	0.69	0.67	0.70	0.76	0.66	0.63	0.67
P9	1.00	0.94	0.71	0.63	0.61	0.64	0.74	0.67	0.64	0.68
P10	1.00	0.95	0.63	0.57	0.55	0.58	0.75	0.70	0.68	0.71
P11	1.00	0.94	0.65	0.57	0.57	0.58	0.84	0.77	0.76	0.78
P12	1.00	0.92	0.82	0.74	0.73	0.75	0.81	0.73	0.71	0.74
P13	1.00	0.93	0.84	0.77	0.76	0.78	0.80	0.72	0.70	0.73
P14	1.00	0.92	0.74	0.64	0.62	0.65	0.78	0.69	0.67	0.71
P15	1.00	0.95	0.64	0.57	0.55	0.58	0.83	0.78	0.76	0.79
P16	1.00	0.94	0.70	0.63	0.63	0.64	0.92	0.86	0.85	0.87
P17	1.00	0.89	0.89	0.78	0.77	0.79	0.93	0.82	0.80	0.83
P18	1.00	0.89	0.94	0.83	0.83	0.84	0.89	0.77	0.76	0.78
P19	1.00	0.92	0.83	0.73	0.72	0.74	0.90	0.82	0.80	0.82
P20	1.00	0.96	0.65	0.58	0.57	0.59	0.90	0.85	0.84	0.86
P21	1.00	0.96	0.58	0.51	0.52	0.52	0.93	0.88	0.87	0.88
P22	1.00	0.91	0.91	0.82	0.82	0.84	0.98	0.89	0.87	0.90
P23	1.00	0.90	1.03	0.91	0.92	0.93	0.95	0.82	0.81	0.83
P24	1.00	0.94	0.78	0.67	0.67	0.68	0.98	0.90	0.89	0.91
P25	1.00	1.00	0.68	0.65	0.64	0.65	0.99	0.97	0.96	0.98
AVG	1.00	0.93	0.76	0.67	0.66	0.68	0.85	0.77	0.75	0.78

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F) and five-factor (5F) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM)*, short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the U.S. output gap with the global output gap (Atanasov, 2018). Test assets are 25 European portfolios sorted by size and momentum (Size-MOM).

Table A25 RMSPE Comparison: Factors, Time-variation and State variables: Japan and Size-B/M

Japan: Size-B/M										
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP1-G	5F	5F-TVP1	5F-TVP2	5F-TVP1-G
P1	1.00	0.97	0.66	0.62	0.62	0.62	0.67	0.63	0.63	0.63
P2	1.00	0.97	0.65	0.60	0.59	0.59	0.65	0.61	0.60	0.61
P3	1.00	0.96	0.69	0.64	0.63	0.64	0.70	0.65	0.64	0.65
P4	1.00	0.96	0.61	0.55	0.55	0.55	0.61	0.55	0.54	0.56
P5	1.00	0.97	0.53	0.48	0.48	0.48	0.53	0.48	0.48	0.49
P6	1.00	0.98	0.68	0.64	0.63	0.63	0.67	0.63	0.62	0.63
P7	1.00	0.97	0.62	0.57	0.56	0.56	0.63	0.57	0.57	0.58
P8	1.00	0.97	0.64	0.60	0.59	0.59	0.64	0.60	0.59	0.60
P9	1.00	0.96	0.62	0.55	0.54	0.55	0.61	0.54	0.53	0.55
P10	1.00	0.97	0.50	0.44	0.44	0.44	0.48	0.43	0.43	0.43
P11	1.00	0.97	0.71	0.66	0.66	0.65	0.71	0.67	0.66	0.66
P12	1.00	0.95	0.81	0.74	0.73	0.73	0.81	0.74	0.73	0.74
P13	1.00	0.96	0.71	0.66	0.65	0.65	0.70	0.65	0.64	0.65
P14	1.00	0.97	0.65	0.61	0.60	0.60	0.65	0.60	0.59	0.60
P15	1.00	0.97	0.54	0.49	0.48	0.49	0.53	0.47	0.47	0.48
P16	1.00	0.96	0.84	0.78	0.77	0.77	0.84	0.78	0.77	0.78
P17	1.00	0.94	0.94	0.86	0.86	0.86	0.92	0.84	0.83	0.84
P18	1.00	0.95	0.95	0.89	0.88	0.88	0.93	0.87	0.85	0.86
P19	1.00	0.96	0.77	0.72	0.71	0.71	0.76	0.71	0.71	0.71
P20	1.00	0.97	0.62	0.58	0.57	0.57	0.61	0.57	0.56	0.57
P21	1.00	0.99	0.73	0.70	0.69	0.68	0.74	0.71	0.69	0.69
P22	1.00	0.96	1.01	0.98	0.96	0.96	1.00	0.96	0.94	0.94
P23	1.00	0.97	0.98	0.95	0.93	0.93	0.99	0.96	0.94	0.95
P24	1.00	1.00	0.84	0.83	0.82	0.82	0.85	0.84	0.83	0.83
P25	1.00	0.97	0.81	0.78	0.77	0.78	0.81	0.77	0.77	0.77
AVG	1.00	0.97	0.72	0.68	0.67	0.67	0.72	0.67	0.67	0.67

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F) and five-factor (5F) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM),* short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the individual output gap with the global output gap (Atanasov, 2018). Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M).

Table A26 RMSPE Comparison: Factors, Time-variation and State variables: Japan and Size-MOM

	Japan: Size-Mom									
	1F	1F-TVP	4F	4F-TVP1	4F-TVP2	4F-TVP1-G	5F	5F-TVP1	5F-TVP2	5F-TVP1-G
P1	1.00	0.96	0.61	0.54	0.53	0.53	0.73	0.67	0.67	0.68
P2	1.00	0.96	0.64	0.58	0.58	0.58	0.67	0.61	0.61	0.62
P3	1.00	0.97	0.61	0.56	0.56	0.56	0.62	0.57	0.57	0.58
P4	1.00	0.97	0.62	0.57	0.57	0.57	0.66	0.62	0.61	0.62
P5	1.00	0.97	0.69	0.65	0.64	0.65	0.73	0.69	0.69	0.69
P6	1.00	0.96	0.60	0.53	0.52	0.52	0.79	0.73	0.73	0.73
P7	1.00	0.97	0.60	0.55	0.54	0.54	0.63	0.59	0.59	0.59
P8	1.00	0.97	0.62	0.58	0.58	0.58	0.61	0.57	0.57	0.57
P9	1.00	0.96	0.60	0.54	0.54	0.54	0.65	0.60	0.60	0.60
P10	1.00	0.97	0.62	0.57	0.56	0.57	0.74	0.70	0.70	0.70
P11	1.00	0.95	0.60	0.52	0.51	0.51	0.85	0.79	0.79	0.80
P12	1.00	0.96	0.69	0.64	0.63	0.63	0.74	0.70	0.70	0.70
P13	1.00	0.97	0.71	0.67	0.67	0.67	0.70	0.67	0.67	0.67
P14	1.00	0.96	0.70	0.64	0.64	0.64	0.76	0.71	0.71	0.72
P15	1.00	0.98	0.65	0.59	0.58	0.59	0.84	0.80	0.80	0.80
P16	1.00	0.95	0.63	0.56	0.55	0.55	0.92	0.87	0.87	0.88
P17	1.00	0.96	0.72	0.66	0.66	0.66	0.84	0.79	0.78	0.79
P18	1.00	0.97	0.88	0.83	0.83	0.83	0.87	0.83	0.82	0.83
P19	1.00	0.96	0.85	0.80	0.79	0.79	0.90	0.85	0.85	0.85
P20	1.00	0.98	0.69	0.64	0.64	0.64	0.91	0.88	0.87	0.87
P21	1.00	0.98	0.60	0.58	0.58	0.58	0.95	0.94	0.93	0.93
P22	1.00	0.99	0.83	0.81	0.79	0.79	0.98	0.96	0.95	0.95
P23	1.00	0.97	1.00	0.96	0.95	0.95	0.99	0.96	0.94	0.95
P24	1.00	1.01	0.92	0.90	0.88	0.89	1.05	1.03	1.02	1.02
P25	1.00	1.02	0.59	0.58	0.57	0.58	0.96	0.96	0.95	0.96
AVG	1.00	0.97	0.69	0.64	0.64	0.64	0.80	0.76	0.76	0.76

Notes: This table presents the root mean squared pricing error (RMSPE) relative to the CAPM (1F). When the value is smaller than one, it indicates that the time-varying model reduces RMSPE. We use the four-factor (4F) and five-factor (5F) models. TVP is the time-varying price of risk model (Adrian, et al. 2015). TVP1 employs the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). TVP2 uses the following state variables: output gap (*GAP*), term spread (*TERM),* short-term rate (*SHO*) and Jurado et al.'s (2015) uncertainty index (*UNC*). TVP1-G replaces the U.S. output gap with the global output gap (Atanasov, 2018). Test assets are 25 Japanese portfolios sorted by size and momentum (Size-MOM).

Table A27 100 Test Portfolios: US

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	four factor	*MKT*	0.53	-7.71 **	0.05	-0.71 ***	0.18	0.57 *
			(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	-0.04	1.87	0.15	-0.16	-0.18	0.20
			(0.22)	(2.22)	(0.11)	(0.19)	(0.22)	(0.13)
		HML	0.13	1.14	0.17	0.21	0.24	0.40 ***
			(0.21)	(2.25)	(0.11)	(0.19)	(0.22)	(0.13)
		UMD	0.65 **	5.43 *	0.05	0.33	0.24	0.76 ***
			(0.30)	(3.05)	(0.16)	(0.26)	(0.31)	(0.25)
(b)	five factor	*MKT*	0.51 *	-7.89 **	0.04	-0.73 ***	0.16	0.53
			(0.31)	(3.14)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	-0.01	2.12	0.17	-0.15	-0.16	0.26 **
			(0.22)	(2.21)	(0.11)	(0.19)	(0.23)	(0.13)
		HML	-0.13	-0.43	0.07	0.13	0.09	-0.02
			(0.23)	(2.38)	(0.12)	(0.19)	(0.23)	(0.14)
		RMW	0.02	1.28	0.19 **	0.19	0.17	0.32 ***
			(0.18)	(1.77)	(0.09)	(0.14)	(0.17)	(0.10)
		CMA	0.39 **	2.60	0.05 **	0.15	0.23	0.48 ***
			(0.18)	(1.81)	(0.09)	(0.15)	(0.17)	(0.13)
(c)	q factor	*MKT*	0.42	-7.92 **	0.07	-0.71 **	0.18	0.51
			(0.33)	(3.25)	(0.17)	(0.28)	(0.32)	(0.34)
		R_ME	-0.02	2.42	0.22 *	-0.09	-0.11	0.35 **
			(0.24)	(2.34)	(0.12)	(0.20)	(0.24)	(0.14)
		R_IA	0.09	1.21	0.12 **	0.16	0.20	0.28 **
			(0.19)	(1.98)	(0.10)	(0.16)	(0.18)	(0.11)
		R_ROE	0.37	3.19	0.12	0.28	0.25	0.58 ***
			(0.24)	(2.47)	(0.12)	(0.21)	(0.24)	(0.16)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We use the four-factor, five-factor and *q*-factor models. We employ the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. We combine 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom), and test assets are 100 US portfolios. The sample period extends from January 1967 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A28 100 Test Portfolios: Europe

Europe			const	GAP	TERM	DEI	UI	mean
(a)	four factor	*MKT*	0.61 ***	-1.88 **	-0.03	0.11 ***	-0.56	0.53 ***
			(0.20)	(0.57)	(0.12)	(0.09)	(1.32)	(0.20)
		SMB	0.06	-0.50 *	0.13 **	0.00	0.34	0.07
			(0.09)	(0.26)	(0.05)	(0.04)	(0.59)	(0.09)
		HML	0.23 **	0.86 ***	0.06	0.08 *	-0.13	0.23 *
			(0.11)	(0.33)	(0.06)	(0.05)	(0.69)	(0.13)
		UMD	1.00 **	0.99 **	-0.14	0.03	-0.60	0.99 ***
			(0.16)	(0.47)	(0.10)	(0.07)	(1.06)	(0.16)
(b)	five factor	*MKT*	0.60 ***	-1.88 ***	-0.03	0.11 ***	-0.55	0.52 ***
			(0.20)	(0.57)	(0.12)	(0.09)	(1.32)	(0.20)
		SMB	0.10	-0.46 *	0.13 **	0.00	0.32	0.11
			(0.09)	(0.26)	(0.05)	(0.04)	(0.59)	(0.09)
		HML	-0.08	0.54	0.07	0.05	0.20	-0.06
			(0.11)	(0.35)	(0.07)	(0.05)	(0.71)	(0.13)
		RMW	0.63 ***	0.27	-0.12 **	0.02	0.11	0.64 ***
			(0.10)	(0.28)	(0.05)	(0.04)	(0.55)	(0.10)
		CMA	0.22 ***	0.98 ***	0.07 **	0.06	-0.29	0.22 **
			(0.08)	(0.24)	(0.05)	(0.04)	(0.51)	(0.10)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We use the four-factor and five-factor models. We employ the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. We combine 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom), and test assets are 100 European portfolios. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A29 100 Test Portfolios: Japan

Japan								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	four factor	*MKT*	0.06	-9.45 ***	0.08	0.96	0.03	0.09
			(0.21)	(3.22)	(1.27)	(1.00)	(0.11)	(0.23)
		SMB	0.17	-5.46 ***	0.08	0.57	0.02	0.19
			(0.12)	(1.90)	(0.77)	(0.61)	(0.07)	(0.15)
		HML	0.13	5.76 ***	-0.40	-0.24	-0.11	0.15
			(0.12)	(1.92)	(0.84)	(0.60)	(0.06)	(0.15)
		UMD	0.16	3.75	2.20	-0.41	0.10	0.11
			(0.17)	(2.66)	(1.04)	(0.82)	(0.09)	(0.18)
(b)	five factor	*MKT*	0.05	-9.57 ***	0.04	0.97 ***	0.03	0.08
			(0.21)	(3.20)	(1.27)	(1.00)	(0.11)	(0.23)
		SMB	0.17	-5.34 ***	0.11 **	0.55	0.03	0.18
			(0.12)	(1.90)	(0.77)	(0.61)	(0.07)	(0.15)
		HML	0.19	1.72	-1.00	0.37	-0.12 *	0.22 *
			(0.12)	(1.93)	(0.78)	(0.57)	(0.06)	(0.13)
		RMW	0.19 *	-1.42	0.64 **	0.44	0.05	0.18
			(0.10)	(1.73)	(0.63)	(0.46)	(0.05)	(0.10)
		CMA	0.00	6.37 ***	-0.09	-0.65	-0.05	-0.01
			(0.10)	(1.49)	(0.61)	(0.46)	(0.05)	(0.12)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We use the four-factor and five-factor models. We employ the following state variables: output gap (*GAP*). term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. We combine 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom), and test assets are 100 Japanese portfolios. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A30 Using the Lagged Output Gap: US

			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.49	-7.15 **	0.10	-0.69 **	0.18	0.61 *
			(0.31)	(3.18)	(0.17)	(0.27)	(0.32)	(0.41)
		SMB	-0.05	2.08	0.16	-0.23	-0.17	0.21
			(0.22)	(2.26)	(0.12)	(0.19)	(0.22)	(0.14)
		HML	0.17	0.72	0.10	0.24	0.24	0.33 ***
			(0.21)	(2.12)	(0.11)	(0.18)	(0.21)	(0.12)
		UMD	-0.33	20.35	2.30 ***	-0.31	0.46	3.30 ***
			(1.14)	(12.55)	(0.78)	(0.95)	(1.06)	(1.02)
(b)	Size-OP	*MKT*	0.55 *	-7.60 **	0.04	-0.72 ***	0.19	0.57
			(0.31)	(3.16)	(0.16)	(0.27)	(0.32)	(0.40)
		SMB	-0.08	3.09	0.15	-0.14	-0.18	0.16
			(0.22)	(2.23)	(0.12)	(0.19)	(0.22)	(0.14)
		HML	-0.23	-0.17	0.51 **	0.23	0.12	0.55 *
			(0.35)	(4.17)	(0.21)	(0.32)	(0.35)	(0.32)
		UMD	0.90	10.07	0.54	0.55	0.40	1.78 ***
			(1.03)	(10.63)	(0.58)	(0.94)	(0.98)	(0.65)
(c)	Size-INV	*MKT*	0.51	-7.41 **	0.07	-0.75 ***	0.16	0.59
			(0.31)	(3.16)	(0.16)	(0.27)	(0.32)	(0.41)
		SMB	-0.09	2.22	0.15	-0.12	-0.20	0.15
			(0.22)	(2.27)	(0.12)	(0.19)	(0.23)	(0.13)
		HML	0.35	0.49	0.15	0.14	0.29	0.58 ***
			(0.25)	(2.70)	(0.14)	(0.22)	(0.25)	(0.16)
		UMD	0.22	21.80 *	0.95	-0.30	-1.24	1.79 **
			(0.97)	(11.59)	(0.58)	(0.93)	(1.04)	(0.83)
(d)	Size-MOM	*MKT*	0.56 *	-7.65 **	0.04	-0.69 **	0.16	0.58
			(0.31)	(3.20)	(0.17)	(0.27)	(0.32)	(0.40)
		SMB	-0.01	2.38	0.14	-0.17	-0.23	0.21
			(0.23)	(2.41)	(0.12)	(0.20)	(0.24)	(0.14)
		HML	-0.03	0.21	0.42 **	0.00	0.51	0.62 **
			(0.35)	(3.93)	(0.19)	(0.29)	(0.33)	(0.28)
		UMD	0.72 **	4.34	0.01	0.35	0.25	0.76 ***
			(0.30)	(3.07)	(0.16)	(0.26)	(0.31)	(0.27)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables in Equation (4) are the U.S. output gap (*GAP*) at $t-1$, term spread (*TERM*) at t, unexpected inflation (*UI*) at t, and change in expected inflation (*DEI*) at t. The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A31 Using the Lagged Output Gap: Europe

			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.64 **	-1.90 **	-0.03	0.12	-0.45	0.55
			(0.28)	(0.81)	(0.16)	(0.13)	(1.85)	(0.37)
		SMB	-0.02	-0.27	0.14	0.00	0.16	-0.02
			(0.12)	(0.37)	(0.07)	(0.06)	(0.81)	(0.13)
		HML	0.19	0.53	0.05	0.06	-0.36	0.18
			(0.14)	(0.45)	(0.08)	(0.07)	(0.96)	(0.15)
		UMD	1.67 **	3.39 **	-0.10 ***	0.19	-3.59	1.52 **
			(0.66)	(1.63)	(0.38)	(0.18)	(2.87)	(0.70)
(b)	Size-OP	*MKT*	0.65 **	-1.91 **	-0.03	0.12	-0.48	0.57
			(0.28)	(0.81)	(0.16)	(0.13)	(1.85)	(0.38)
		SMB	0.06	-0.26	0.15 **	0.01	0.11	0.06
			(0.13)	(0.36)	(0.08)	(0.06)	(0.82)	(0.14)
		HML	0.01	-0.49	-0.16	0.06	2.04 *	0.12
			(0.23)	(0.61)	(0.13)	(0.09)	(1.22)	(0.28)
		UMD	2.46 ***	0.05	-0.60	0.18	1.19	2.52 ***
			(0.72)	(1.47)	(0.38)	(0.22)	(3.03)	(0.75)
(c)	Size-INV	*MKT*	0.60 **	-1.89 **	-0.02	0.11	-0.47	0.51
			(0.27)	(0.80)	(0.16)	(0.13)	(1.85)	(0.37)
		SMB	0.04	-0.29	0.14 **	0.00	-0.02	0.03
			(0.12)	(0.37)	(0.08)	(0.06)	(0.82)	(0.14)
		HML	0.37 **	0.37	0.08	0.13 *	1.83	0.48 *
			(0.19)	(0.64)	(0.13)	(0.08)	(1.21)	(0.29)
		UMD	0.40	1.75	0.39	-0.11	-3.83	0.23 **
			(0.65)	(2.37)	(0.45)	(0.24)	(4.15)	(0.70)
(d)	Size-MOM	*MKT*	0.59 **	-1.90 **	-0.03	0.11 **	-0.50	0.50
			(0.28)	(0.81)	(0.16)	(0.13)	(1.85)	(0.37)
		SMB	0.14	-0.30	0.15	-0.01	0.04	0.13
			(0.13)	(0.38)	(0.08)	(0.06)	(0.84)	(0.15)
		HML	0.73 **	0.73	-0.07	0.22	1.55	0.83 *
			(0.37)	(1.06)	(0.24)	(0.13)	(1.87)	(0.46)
		UMD	0.97 ***	0.96	-0.14	0.02	-0.62	0.95 ***
			(0.23)	(0.65)	(0.13)	(0.10)	(1.49)	(0.23)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables in Equation (4) are the European output gap (*GAP*) at $t-1$, term spread (*TERM*) at t, unexpected inflation (*UI*) at t, and change in expected inflation (*DEI*) at t. The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A32 Using the Lagged Output Gap: Japan

Japan									
			const	*GAP*	*TERM*	*DEI*	*UI*		mean
(a)	Size-B/M	*MKT*	0.10	-10.87 **	0.11	1.03	0.06		0.12
			(0.29)	(4.48)	(1.76)	(1.39)	(0.15)		(0.35)
		SMB	0.13	-4.50 *	0.08	0.44	0.01		0.15
			(0.17)	(2.67)	(1.07)	(0.84)	(0.09)		(0.20)
		HML	0.21	2.02	-0.13	0.10	-0.11		0.24
			(0.16)	(2.50)	(1.01)	(0.78)	(0.08)		(0.17)
		UMD	0.77	-0.30	2.24	0.19	-0.17		0.83
			(0.66)	(9.24)	(5.21)	(2.72)	(0.28)		(0.66)
(b)	Size-OP	*MKT*	0.10	-11.03 **	-0.09	1.04	0.04		0.12
			(0.29)	(4.49)	(1.76)	(1.39)	(0.15)		(0.35)
		SMB	0.22	-6.46 **	0.03	0.88	0.04		0.23
			(0.17)	(2.71)	(1.08)	(0.86)	(0.09)		(0.22)
		HML	-0.44	16.00 ***	-0.73	-2.94 *	-0.23		-0.42
			(0.31)	(5.80)	(1.97)	(1.54)	(0.19)		(0.46)
		UMD	0.58	2.15	-1.48	-1.98	-0.25		0.65
			(0.65)	(10.83)	(4.64)	(3.14)	(0.32)		(0.66)
(c)	Size-INV	*MKT*	0.07	-10.87 **	-0.11	0.98	0.05		0.09
			(0.29)	(4.50)	(1.76)	(1.39)	(0.15)		(0.35)
		SMB	0.19	-5.28 *	-0.07	0.72	0.01		0.20
			(0.17)	(2.68)	(1.07)	(0.86)	(0.09)		(0.21)
		HML	0.05	13.94 ***	-0.90	-1.57	-0.07		0.02
			(0.24)	(4.29)	(1.76)	(1.13)	(0.13)		(0.39)
		UMD	0.38	9.58	0.74	-2.03	-0.02		0.35
			(0.51)	(8.43)	(3.35)	(2.27)	(0.25)		(0.53)
(d)	Size-MOM	*MKT*	0.05	-10.32 **	0.32	0.94	0.06		0.06
			(0.29)	(4.48)	(1.78)	(1.40)	(0.15)		(0.34)
		SMB	0.27	-7.75 ***	0.76	0.70	0.06		0.28
			(0.18)	(3.01)	(1.13)	(0.90)	(0.10)		(0.25)
		HML	-0.04	8.96	-3.82	0.79	-0.21		0.00
			(0.39)	(7.06)	(3.18)	(1.79)	(0.20)		(0.43)
		UMD	0.12	5.10	2.25	-0.51	0.09		0.07
			(0.24)	(3.72)	(1.44)	(1.13)	(0.12)		(0.26)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables in Equation (4) are the European output gap (*GAP*) at $t-1$, term spread (*TERM*) at t, unexpected inflation (*UI*) at t, and change in expected inflation (*DEI*) at t. The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A33 Using Industry portfolios

			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Industry	*MKT*	0.49	-7.47 **	0.07	-0.70 **	0.21	0.57 *
			(0.32)	(3.26)	(0.17)	(0.28)	(0.33)	(0.34)
(b)	Industry	*MKT*	0.59 *	-6.66 **	0.07	-0.84 ***	0.20	0.67 *
			(0.31)	(3.28)	(0.17)	(0.28)	(0.32)	(0.31)
		SMB	-0.16	6.15	-0.10	-0.14	0.34	-0.28
			(0.37)	(4.41)	(0.20)	(0.37)	(0.40)	(0.33)
		HML	-0.31	2.92	0.06	-0.16	0.29	-0.21 *
			(0.32)	(3.91)	(0.18)	(0.32)	(0.34)	(0.20)
		UMD	0.27	38.71 ***	-0.19	-2.71 *	1.28	0.19 ***
			(0.97)	(14.39)	(0.53)	(1.43)	(1.26)	(1.43)
(c)	Industry	*MKT*	0.51	-7.39 **	0.07	-0.66 **	0.15	0.58 *
			(0.31)	(3.19)	(0.16)	(0.28)	(0.32)	(0.33)
		SMB	0.04	4.71	-0.17	-0.25	0.38	-0.19
			(0.38)	(4.29)	(0.21)	(0.38)	(0.43)	(0.32)
		HML	-0.55	-2.36	0.11	0.50 *	0.02	-0.39 **
			(0.29)	(3.36)	(0.16)	(0.25)	(0.30)	(0.18)
		RMW	0.06	-6.84	0.21	0.15	-0.30	0.35
			(0.35)	(4.25)	(0.19)	(0.36)	(0.39)	(0.38)
		CMA	0.10	10.86 *	-0.22	-0.77 *	0.56	-0.17 **
			(0.43)	(5.72)	(0.24)	(0.46)	(0.50)	(0.50)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The last column indicates the average price of risk on the risk factors in Equation (5). Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 30 US industry portfolios and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A34 Using the Vintage of Industrial Production

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.49	-7.20 **	0.10	-0.69 **	0.18	0.61 *
			(0.31)	(3.16)	(0.17)	(0.27)	(0.32)	(0.33)
		SMB	-0.03	1.60	0.15	-0.23	-0.16	0.21
			(0.22)	(2.25)	(0.12)	(0.19)	(0.22)	(0.14)
		HML	0.14	1.30	0.12	0.23	0.23	0.33 **
			(0.20)	(2.10)	(0.11)	(0.18)	(0.21)	(0.13)
		UMD	-0.44	22.99 *	2.37 ***	-0.34	0.42	3.31 ***
			(1.14)	(12.61)	(0.79)	(0.95)	(1.06)	(1.01)
(b)	Size-OP	*MKT*	0.54	-7.55 **	0.04	-0.72 ***	0.18	0.57 *
			(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.32)
		SMB	-0.05	2.52	0.13	-0.13	-0.17	0.16
			(0.22)	(2.21)	(0.12)	(0.19)	(0.22)	(0.13)
		HML	-0.23	-0.09	0.51 **	0.22	0.12	0.55 *
			(0.34)	(4.09)	(0.20)	(0.32)	(0.35)	(0.29)
		UMD	0.78	12.53	0.61	0.53	0.36	1.78 **
			(1.03)	(10.61)	(0.59)	(0.94)	(0.97)	(0.65)
(c)	Size-INV	*MKT*	0.51 *	-7.40 **	0.08	-0.75 ***	0.16	0.59 *
			(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	-0.07	1.70	0.14	-0.11	-0.19	0.15
			(0.22)	(2.26)	(0.12)	(0.19)	(0.23)	(0.13)
		HML	0.34	0.82	0.16	0.14	0.28	0.58 ***
			(0.25)	(2.68)	(0.14)	(0.22)	(0.25)	(0.15)
		UMD	0.17	23.36 **	0.99 *	-0.32	-1.27	1.80 **
			(0.96)	(11.32)	(0.57)	(0.93)	(1.04)	(0.80)
(d)	Size-MOM	*MKT*	0.55	-7.61 **	0.04	-0.69 **	0.16	0.58 *
			(0.31)	(3.17)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	0.02	1.68	0.12	-0.16	-0.22	0.21
			(0.23)	(2.39)	(0.12)	(0.20)	(0.24)	(0.14)
		HML	-0.03	0.30	0.42 **	-0.01	0.51	0.62 **
			(0.35)	(3.92)	(0.19)	(0.29)	(0.33)	(0.25)
		UMD	0.69 **	5.13 *	0.03	0.34	0.24	0.76 ***
			(0.30)	(3.04)	(0.16)	(0.26)	(0.30)	(0.25)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). We use the vintage of the industrial production index obtained from the dataset of the Federal Reserve Bank of Philadelphia and estimate the output gap. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A35 Using 25 U.S. Portfolios Sorted by Investment and Profitability

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Four-factor	*MKT*	0.50	-7.53 **	0.07	-0.75 ***	0.15	0.58 *
			(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	0.15	1.50	-0.17	-0.40	-0.33	-0.11
			(0.36)	(3.99)	(0.21)	(0.35)	(0.37)	(0.23)
		HML	0.19	0.72	0.14	0.21	0.15	0.40 **
			(0.28)	(3.03)	(0.15)	(0.25)	(0.28)	(0.16)
		UMD	0.55	15.89	0.39	-1.28	-0.98	1.23 *
			(0.92)	(10.16)	(0.52)	(0.88)	(1.06)	(0.66)
(b)	Five-factor	*MKT*	0.47	-7.47 **	0.06	-0.80 ***	0.13	0.52
			(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
		SMB	0.77	-3.38	-0.13	0.34	0.08	0.55 **
			(0.47)	(4.50)	(0.25)	(0.44)	(0.52)	(0.25)
		HML	-0.27	3.10	0.28	0.77 **	0.13	0.18
			(0.42)	(4.11)	(0.22)	(0.34)	(0.40)	(0.23)
		RMW	0.24	-0.44	0.11	0.39 *	0.16	0.41 ***
			(0.22)	(2.18)	(0.07)	(0.20)	(0.23)	(0.13)
		CMA	0.13	0.65	0.02	0.04	0.05	0.16 *
			(0.16)	(1.63)	(0.08)	(0.14)	(0.16)	(0.09)
(c)	q-factor	*MKT*	0.42	-7.44 **	0.07	-0.74 ***	0.18	0.52
			(0.33)	(3.25)	(0.17)	(0.28)	(0.32)	(0.33)
		SMB	0.30	-0.74	0.18	0.04	-0.18	0.58 *
			(0.63)	(5.98)	(0.32)	(0.53)	(0.57)	(0.35)
		HML	0.18	0.87	0.04	0.11	0.07	0.25 ***
			(0.16)	(1.62)	(0.09)	(0.13)	(0.15)	(0.09)
		RMW	0.34	0.70	0.31	0.29	0.05	0.84 ***
			(0.51)	(4.76)	(0.27)	(0.47)	(0.47)	(0.30)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We employ the four-factor, five-factor, and *q*-factor models. The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). Test assets are 25 U.S. portfolios sorted by operating profitability (OP) or investment (Inv). The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A36 Using the Dividend-price Ratio and the Default Spread: Four-factor model

US								
			const	*GAP*	*TERM*	*DP*	*DEF*	mean
(a)	Size-B/M	*MKT*	0.41	-7.40 **	0.12	-0.02	0.11	0.61 ***
			(0.67)	(3.46)	(0.18)	(0.18)	(0.46)	(0.10)
		SMB	-0.94 **	3.61	0.18	0.16	0.39	0.21
			(0.47)	(2.42)	(0.13)	(0.12)	(0.33)	(0.18)
		HML	-0.13	2.37	0.20 *	0.20 *	-0.43	0.32
			(0.44)	(2.27)	(0.12)	(0.12)	(0.31)	(0.21)
		UMD	0.45	20.39	2.38 ***	-0.25	-0.10	3.38 **
			(2.13)	(13.25)	(0.79)	(0.63)	(1.76)	(1.45)
(b)	Size-OP	*MKT*	0.48	-7.80 **	0.08	-0.01	0.03	0.57 ***
			(0.66)	(3.44)	(0.17)	(0.17)	(0.46)	(0.08)
		SMB	-0.85 *	4.32 *	0.13	0.10	0.47	0.16
			(0.47)	(2.39)	(0.12)	(0.12)	(0.33)	(0.14)
		HML	-0.93	1.94	0.59 ***	0.25	-0.15	0.54 *
			(0.73)	(4.05)	(0.21)	(0.21)	(0.52)	(0.28)
		UMD	3.21	7.09	0.55	-0.57	-0.57	1.85 **
			(2.19)	(10.76)	(0.64)	(0.60)	(1.50)	(0.73)
(c)	Size-INV	*MKT*	0.41	-7.62 **	0.11	0.00	0.06	0.59 ***
			(0.66)	(3.43)	(0.17)	(0.17)	(0.46)	(0.08)
		SMB	-0.85 *	3.44	0.15	0.13	0.37	0.15
			(0.47)	(2.41)	(0.12)	(0.13)	(0.34)	(0.14)
		HML	-0.28	2.70	0.21	0.13	0.13	0.56 ***
			(0.54)	(2.82)	(0.14)	(0.15)	(0.39)	(0.17)
		UMD	3.37	13.31	0.81	-0.43	-1.52	1.86 **
			(2.12)	(11.67)	(0.57)	(0.56)	(1.68)	(0.80)
(d)	Size-MOM	*MKT*	0.30	-7.39 **	0.10	0.07	-0.03	0.59 ***
			(0.67)	(3.49)	(0.17)	(0.18)	(0.46)	(0.09)
		SMB	-0.69	3.16	0.10	0.04	0.58	0.20
			(0.49)	(2.56)	(0.13)	(0.13)	(0.36)	(0.14)
		HML	-0.42	1.94	0.47 **	0.02	0.22	0.59 **
			(0.77)	(4.04)	(0.20)	(0.21)	(0.53)	(0.25)
		UMD	0.85	5.03	0.17	0.33 **	-1.31 ***	0.76 ***
			(0.63)	(3.29)	(0.16)	(0.17)	(0.45)	(0.19)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We employ the four-factor model. The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), dividend-price ratio (*DP*) and default spread (*DEF*) as in Chen et al. (1986), Adrian et al., (2015), Cooper and Priestley (2011) and Cooper et al. (2022). Test assets are 25 U.S. portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A37 Using the Dividend-price Ratio and the Default Spread: Five-factor model

US							
		const	*GAP*	*TERM*	*DP*	*DEF*	mean
(a) Size-B/M	*MKT*	0.45	-7.86 **	0.04	-0.03	0.09	0.48 ***
		(0.67)	(3.47)	(0.17)	(0.18)	(0.46)	(0.09)
	SMB	-1.04 **	3.68	0.23 **	0.17	0.44	0.30 **
		(0.46)	(2.39)	(0.12)	(0.12)	(0.32)	(0.14)
	HML	-0.03	1.72	0.11	0.20 *	-0.48	0.23
		(0.44)	(2.26)	(0.11)	(0.11)	(0.31)	(0.14)
	RMW	-0.45	0.02	0.27	0.06	0.21	0.37 *
		(0.64)	(3.35)	(0.20)	(0.18)	(0.52)	(0.20)
	CMA	-0.16	6.77 **	0.32 *	0.00	-0.16	0.18
		(0.61)	(3.41)	(0.18)	(0.17)	(0.50)	(0.20)
(b) Size-OP	*MKT*	0.41	-7.81 **	0.08	0.00	0.07	0.56 ***
		(0.66)	(3.45)	(0.17)	(0.18)	(0.46)	(0.08)
	SMB	-0.83 *	4.38 *	0.14	0.10	0.47	0.18
		(0.47)	(2.39)	(0.12)	(0.13)	(0.33)	(0.13)
	HML	-0.96	0.25	0.37 **	0.33 **	-0.45	0.09
		(0.63)	(3.17)	(0.16)	(0.16)	(0.43)	(0.24)
	RMW	0.02	0.39	0.12	-0.03	0.08	0.21 **
		(0.33)	(1.73)	(0.08)	(0.09)	(0.23)	(0.09)
	CMA	1.00	3.31	0.02	-0.29	-0.10	0.09
		(0.73)	(3.66)	(0.19)	(0.21)	(0.52)	(0.26)
(c) Size-INV	*MKT*	0.49	-7.95 **	0.08	-0.03	0.07	0.57 ***
		(0.66)	(3.44)	(0.17)	(0.18)	(0.46)	(0.08)
	SMB	-1.23 **	3.59	0.16	0.23 *	0.43	0.14
		(0.48)	(2.46)	(0.13)	(0.13)	(0.34)	(0.16)
	HML	1.10	5.32	0.44 *	-0.26	-0.33	0.71 **
		(0.91)	(4.79)	(0.26)	(0.25)	(0.59)	(0.33)
	RMW	-1.59 *	1.97	0.15	0.40 *	0.12	-0.08
		(0.84)	(4.48)	(0.23)	(0.22)	(0.53)	(0.27)
	CMA	-0.03	0.68	-0.04	0.06	0.12	0.20 **
		(0.32)	(1.69)	(0.09)	(0.09)	(0.23)	(0.09)
(d) Size-MOM	*MKT*	0.39	-7.86 **	0.09	0.05	-0.04	0.59 ***
		(0.68)	(3.51)	(0.17)	(0.18)	(0.47)	(0.11)
	SMB	-0.64	4.56 *	0.18	0.13	0.36	0.41 **
		(0.52)	(2.65)	(0.13)	(0.14)	(0.36)	(0.17)
	HML	-1.00	-3.70	0.06	-0.41	1.53 *	-0.55
		(0.97)	(4.93)	(0.24)	(0.27)	(0.82)	(0.43)
	RMW	-0.28	4.88	0.18	0.26	-0.47	0.30
		(1.03)	(4.96)	(0.25)	(0.27)	(0.85)	(0.44)
	CMA	1.02	0.42	0.33	0.01	-0.63	0.91 **
		(1.01)	(5.56)	(0.28)	(0.28)	(0.87)	(0.41)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We employ the five-factor model. The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), dividend-price ratio (*DP*) and default spread (*DEF*) as in Chen et al. (1986), Adrian et al., (2015), Cooper and Priestley (2011) and Cooper et al. (2022). Test assets are 25 U.S. portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A38 Using the Dividend-price Ratio and the Default Spread: *q*-factor model

US							
		const	*GAP*	*TERM*	*DP*	*DEF*	mean
(a) Size-B/M	*MKT*	0.39	-8.12 **	0.04	-0.03	0.13	0.48 ***
		(0.71)	(3.63)	(0.18)	(0.18)	(0.50)	(0.09)
	R_ME	-1.46 ***	5.40 **	0.38 ***	0.14	0.74 **	0.36 **
		(0.51)	(2.62)	(0.13)	(0.13)	(0.37)	(0.16)
	R_IA	-0.29	3.19	0.25 **	0.17	-0.28	0.31 **
		(0.48)	(2.38)	(0.12)	(0.12)	(0.35)	(0.14)
	R_ROE	-0.80	4.26	0.54 **	-0.07	0.57	0.49 *
		(0.82)	(4.18)	(0.23)	(0.22)	(0.66)	(0.25)
(b) Size-OP	*MKT*	0.26	-7.50 **	0.11	-0.01	0.16	0.55 ***
		(0.71)	(3.61)	(0.18)	(0.18)	(0.50)	(0.08)
	R_ME	-1.22	5.13 **	0.25 *	0.09	0.72 **	0.23
		(0.52)	(2.61)	(0.13)	(0.13)	(0.37)	(0.15)
	R_IA	-0.23	-0.58	0.24	0.19	-0.55	0.11
		(0.59)	(2.94)	(0.15)	(0.14)	(0.48)	(0.18)
	R_ROE	-0.15	1.27	0.25 *	-0.03	0.23	0.41 **
		(0.62)	(3.06)	(0.15)	(0.16)	(0.50)	(0.16)
(c) Size-INV	*MKT*	0.29	-7.69 **	0.10	-0.03	0.18	0.54 ***
		(0.71)	(3.60)	(0.18)	(0.18)	(0.50)	(0.08)
	R_ME	-1.38 ***	5.43 **	0.34 ***	0.17	0.56	0.28 *
		(0.52)	(2.60)	(0.13)	(0.13)	(0.38)	(0.16)
	R_IA	0.04	1.82	0.07	0.06	-0.01	0.32 ***
		(0.35)	(1.77)	(0.09)	(0.09)	(0.25)	(0.09)
	R_ROE	-0.97	6.06	0.54 **	0.22	-0.19	0.35 *
		(0.84)	(4.26)	(0.22)	(0.21)	(0.57)	(0.21)
(d) Size-MOM	*MKT*	0.14	-7.55 **	0.11	0.03	0.15	0.52 ***
		(0.71)	(3.66)	(0.18)	(0.18)	(0.51)	(0.09)
	R_ME	-0.78	4.94 *	0.23	0.11	0.49	0.47 ***
		(0.55)	(2.78)	(0.14)	(0.14)	(0.40)	(0.16)
	R_IA	-0.76	1.00	0.29	-0.15	0.79 *	0.12
		(0.66)	(3.65)	(0.19)	(0.19)	(0.46)	(0.22)
	R_ROE	1.12 *	3.54	0.12	0.36 **	-1.54 ***	0.72 ***
		(0.66)	(3.38)	(0.16)	(0.18)	(0.56)	(0.23)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). We employ the *q*-factor model. The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), dividend-price ratio (*DP*) and default spread (*DEF*) as in Chen et al. (1986), Adrian et al., (2015), Cooper and Priestley (2011) and Cooper et al. (2022). Test assets are 25 U.S. portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A39 q^5-factor Model

US							
		const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a) Size-B/M	*MKT*	0.53	-8.28 **	0.01	-0.66 **	0.15	0.52
		(0.33)	(3.25)	(0.17)	(0.28)	(0.33)	(0.33)
	R_ME	-0.18	2.13	0.34	-0.17	-0.05	0.37 **
		(0.24)	(2.41)	(0.13) ***	(0.20)	(0.24)	(0.15)
	R_IA	0.02	1.91	0.18	0.23	0.27	0.32 **
		(0.21)	(2.25)	(0.12)	(0.19)	(0.21)	(0.12)
	R_ROE	-0.30	2.16	0.52 **	0.17	0.42	0.55 **
		(0.42)	(4.14)	(0.23)	(0.31)	(0.39)	(0.25)
	R_EG	0.69	-2.18	-0.01	0.22	-0.16	0.66 **
		(0.47)	(4.61)	(0.25)	(0.36)	(0.40)	(0.27)
(b) Size-OP	*MKT*	0.48	-7.50 **	0.07	-0.71 ***	0.21	0.56 *
		(0.33)	(3.23)	(0.17)	(0.28)	(0.32)	(0.32)
	R_ME	-0.14	2.59	0.23 *	-0.07	-0.13	0.24 *
		(0.25)	(2.43)	(0.13)	(0.21)	(0.25)	(0.14)
	R_IA	-0.11	-0.26	0.16	0.03	0.15	0.15
		(0.26)	(2.74)	(0.14)	(0.23)	(0.27)	(0.16)
	R_ROE	0.03	0.84	0.25 *	0.25	0.11	0.44 **
		(0.27)	(2.91)	(0.08)	(0.29)	(0.29)	(0.16)
	R_EG	0.26	4.27	0.00	0.08	0.32	0.28
		(0.48)	(4.56)	(0.25)	(0.41)	(0.47)	(0.28)
(c) Size-INV	*MKT*	0.47	-7.46 **	0.08	-0.76 ***	0.17	0.57 *
		(0.33)	(3.23)	(0.17)	(0.28)	(0.32)	(0.33)
	R_ME	-0.17	2.97	0.31	-0.06	-0.16	0.33 **
		(0.25)	(2.43)	(0.13) **	(0.21)	(0.25)	(0.15)
	R_IA	0.24	0.80	0.04	0.12	0.16	0.30 ***
		(0.17)	(1.69)	(0.09)	(0.14)	(0.16)	(0.09)
	R_ROE	-0.33	5.63	0.50 **	0.19	0.09	0.50 **
		(0.36)	(3.76)	(0.20)	(0.33)	(0.35)	(0.22)
	R_EG	0.38	9.43	0.29	-0.27	-0.47	0.88 **
		(0.57)	(6.03)	(0.31)	(0.58)	(0.60)	(0.39)
(d) Size-MOM	*MKT*	0.41	-7.65 **	0.07	-0.71 **	0.16	0.50
		(0.33)	(3.28)	(0.17)	(0.28)	(0.33)	(0.33)
	R_ME	0.17	2.29	0.20	-0.04	-0.08	0.49 ***
		(0.25)	(2.45)	(0.13)	(0.22)	(0.25)	(0.15)
	R_IA	-0.38	0.09	0.30 *	-0.18	0.28 *	0.12
		(0.35)	(3.42)	(0.18)	(0.25)	(0.28)	(0.23)
	R_ROE	0.82 **	2.81	-0.03	0.45 *	0.33	0.79 ***
		(0.37)	(3.48)	(0.18)	(0.28)	(0.32)	(0.27)
	R_EG	-0.19	4.88	0.10	-0.09	0.06	-0.02
		(0.62)	(5.76)	(0.32)	(0.51)	(0.53)	(0.35)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*R_ME*), investment (*R_IV*), profitability (*R_ROE*), and expected profitability (*R_EG*) as proposed by Hou et al. (2021). The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A40 Six-factor Model

US							
		const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a) Size-B/M	*MKT*	0.51	-7.20 **	0.06	-0.71 ***	0.12	0.56 *
		(0.31)	(3.14)	(0.17)	(0.27)	(0.32)	(0.32)
	SMB	-0.02	1.27	0.20 *	-0.17	-0.09	0.29 **
		(0.22)	(2.19)	(0.12)	(0.19)	(0.22)	(0.13)
	HML	0.17	1.19	0.06	0.23	0.16	0.27 **
		(0.20)	(2.08)	(0.11)	(0.18)	(0.21)	(0.13)
	RMW	0.05	-1.38	0.31	0.40	0.48	0.52
		(0.35)	(3.64)	(0.23)	(0.27)	(0.34)	(0.33)
	CMA	-0.35	6.29 *	0.19	-0.23	0.01	-0.03
		(0.33)	(3.53)	(0.21)	(0.27)	(0.33)	(0.31)
	UMD	0.35	16.23	1.73 **	0.10	-0.12	3.08 **
		(1.06)	(11.65)	(0.68)	(1.01)	(1.02)	(0.96)
(b) Size-OP	*MKT*	0.54	-7.68 **	0.04	-0.72 ***	0.17	0.57 *
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
	SMB	-0.05	2.59	0.14	-0.13	-0.16	0.17
		(0.22)	(2.21)	(0.11)	(0.19)	(0.23)	(0.13)
	HML	-0.24	-0.94	0.28	0.14	-0.06	0.18 **
		(0.31)	(3.19)	(0.17)	(0.28)	(0.35)	(0.20)
	RMW	0.01	0.27	0.13	0.14	0.05	0.21
		(0.16)	(1.59)	(0.07)	(0.27)	(0.16)	(0.09)
	CMA	-0.11	4.53	0.06	0.10	0.67 **	0.00
		(0.32)	(3.57)	(0.18)	(0.28)	(0.35)	(0.25)
	UMD	0.75	8.15	0.01	0.33	-0.48	0.80
		(0.95)	(10.15)	(0.52)	(0.83)	(1.01)	(0.57)
(c) Size-INV	*MKT*	0.53 *	-7.34 **	0.07	-0.77 ***	0.15	0.60 *
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
	SMB	-0.06	0.72	0.12	-0.06	-0.18	0.12
		(0.23)	(2.29)	(0.12)	(0.20)	(0.23)	(0.13)
	HML	-0.10	7.82	0.48 *	-0.03	0.30	0.68 *
		(0.48)	(4.86)	(0.26)	(0.40)	(0.46)	(0.31)
	RMW	-0.11	-2.14	0.03	0.33	0.08	-0.08
		(0.42)	(4.38)	(0.23)	(0.27)	(0.37)	(0.25)
	CMA	0.32 **	0.28	-0.04	0.10	0.03	0.27 ***
		(0.15)	(1.57)	(0.08)	(0.14)	(0.16)	(0.09)
	UMD	1.06	15.25	0.42	-0.35	-1.40	1.77 **
		(0.91)	(11.09)	(0.54)	(0.95)	(1.05)	(0.70)
(d) Size-MOM	*MKT*	0.58 *	-7.80 **	0.05	-0.79 ***	0.09	0.61 *
		(0.31)	(3.23)	(0.17)	(0.28)	(0.32)	(0.34)
	SMB	-0.01	3.24	0.15	-0.06	-0.06	0.24
		(0.25)	(2.63)	(0.13)	(0.22)	(0.25)	(0.16)
	HML	0.03	-7.75	0.22	-0.17	-0.11	0.33
		(0.58)	(6.57)	(0.30)	(0.49)	(0.53)	(0.48)
	RMW	-0.19	3.89	0.05	0.81 ***	0.73	-0.09
		(0.55)	(5.94)	(0.29)	(0.28)	(0.49)	(0.40)
	CMA	0.18	3.96	0.32	-0.95 **	-0.20	0.69 **
		(0.48)	(5.68)	(0.26)	(0.42)	(0.47)	(0.31)
	UMD	0.69 **	4.71	0.02	0.33	0.21	0.74 **
		(0.30)	(3.03)	(0.16)	(0.26)	(0.30)	(0.24)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*), investment (*CMA*), and momentum *(UMD)* as proposed by Fama and French (2015). The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A41 Six-factor Model and 100 Test Portfolios.

US							
		const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a) 100 portfolios	*MKT*	0.53 *	-7.74 **	0.04	-0.72 ***	0.17	0.56 *
		(0.31)	(3.13)	(0.16)	(0.27)	(0.32)	(0.33)
	SMB	-0.05	1.92	0.17	-0.16	-0.17	0.22 *
		(0.22)	(2.20)	(0.11)	(0.19)	(0.22)	(0.13)
	HML	0.13	0.98	0.08	0.25	0.18	0.25 **
		(0.21)	(2.09)	(0.11)	(0.18)	(0.21)	(0.12)
	RMW	-0.10	0.64	0.19 **	0.14	0.12	0.19 *
		(0.17)	(1.72)	(0.09)	(0.27)	(0.17)	(0.10)
	CMA	0.17	1.41	0.05	0.05	0.15	0.25 ***
		(0.15)	(1.55)	(0.08)	(0.13)	(0.15)	(0.09)
	UMD	0.65 **	5.41 *	0.03	0.34	0.23	0.73 ***
		(0.30)	(3.04)	(0.16)	(0.26)	(0.30)	(0.25)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*), profitability (*RMW*), investment (*CMA*), and momentum *(UMD)* as proposed by Fama and French (2018). We combine 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom), and test assets are 100 US portfolios. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A42 Four-factor Model and HP Filter: U.S.

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.49 *	-3.47 ***	0.08	-0.57 **	0.35	0.61 **
			(0.28)	(0.80)	(0.15)	(0.27)	(0.32)	(0.24)
		SMB	0.24	-1.92 ***	-0.02	-0.11	0.03	0.21
			(0.20)	(0.57)	(0.11)	(0.19)	(0.22)	(0.16)
		HML	0.18	0.18	0.09	0.23	0.24	0.32 **
			(0.19)	(0.54)	(0.10)	(0.18)	(0.21)	(0.13)
		UMD	0.16	4.80 *	2.05 ***	-0.48	0.39	3.31 ***
			(0.99)	(2.92)	(0.65)	(0.96)	(1.06)	(1.03)
(b)	Size-OP	*MKT*	0.52 *	-3.47 ***	0.03	-0.61 **	0.35	0.57 **
			(0.28)	(0.79)	(0.14)	(0.27)	(0.32)	(0.23)
		SMB	0.27	-1.98 ***	-0.07	0.00	0.05	0.16
			(0.20)	(0.56)	(0.10)	(0.19)	(0.22)	(0.14)
		HML	-0.14	-1.03	0.45 ***	0.27	0.21	0.54 **
			(0.32)	(0.88)	(0.17)	(0.32)	(0.35)	(0.27)
		UMD	1.24	1.25	0.37	0.51	0.38	1.82 ***
			(1.02)	(2.57)	(0.55)	(0.97)	(1.02)	(0.61)
(c)	Size-INV	*MKT*	0.51 *	-3.60 ***	0.05	-0.63 **	0.34	0.59 **
			(0.28)	(0.79)	(0.14)	(0.27)	(0.32)	(0.24)
		SMB	0.21	-1.96 ***	-0.04	0.01	0.01	0.15
			(0.20)	(0.57)	(0.10)	(0.19)	(0.22)	(0.15)
		HML	0.36	0.11	0.14	0.14	0.29	0.58 ***
			(0.24)	(0.66)	(0.12)	(0.22)	(0.26)	(0.16)
		UMD	1.25	1.17	0.36	-0.27	-1.01	1.80 ***
			(0.92)	(2.83)	(0.47)	(0.92)	(1.04)	(0.67)
(d)	Size-MOM	*MKT*	0.53 *	-3.53 ***	0.03	-0.57 **	0.33	0.58 **
			(0.28)	(0.80)	(0.15)	(0.27)	(0.32)	(0.24)
		SMB	0.32	-2.27 ***	-0.07	-0.02	0.01	0.21
			(0.21)	(0.60)	(0.11)	(0.20)	(0.23)	(0.16)
		HML	-0.01	-0.05	0.41 **	0.00	0.52	0.62 **
			(0.33)	(1.06)	(0.18)	(0.29)	(0.32)	(0.25)
		UMD	0.69 **	2.45 ***	0.04	0.26	0.12	0.76 ***
			(0.27)	(0.78)	(0.14)	(0.26)	(0.31)	(0.21)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using the HP filter (Hodrick, and Prescott, 1997). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A43 Four-factor Model and HP Filter: Europe

Europe								
		const	*GAP*	*TERM*	*DEI*	*UI*		mean
(a) Size-B/M	*MKT*	0.63 **	-5.21 ***	-0.09	0.11	-1.32		0.55 *
		(0.27)	(1.27)	(0.16)	(0.13)	(1.64)		(0.31)
	SMB	-0.03	-1.58 ***	0.11	0.00	0.24		-0.02
		(0.12)	(0.59)	(0.07)	(0.06)	(0.72)		(0.13)
	HML	0.17	-0.26	0.03	0.05	0.28		0.18
		(0.14)	(0.75)	(0.09)	(0.07)	(0.85)		(0.14)
	UMD	1.60 **	3.87 *	-0.11	0.18	-0.78		1.54 **
		(0.64)	(2.26)	(0.38)	(0.18)	(2.60)		(0.66)
(b) Size-OP	*MKT*	0.65 **	-5.23 ***	-0.09	0.11	-1.36		0.57 *
		(0.27)	(1.27)	(0.16)	(0.13)	(1.64)		(0.31)
	SMB	0.04	-1.72 ***	0.12	0.00	0.21		0.06
		(0.13)	(0.59)	(0.07)	(0.06)	(0.72)		(0.14)
	HML	0.04	-0.31	-0.16	0.07	1.64		0.13
		(0.24)	(0.90)	(0.14)	(0.09)	(1.12)		(0.29)
	UMD	2.53 ***	1.55	-0.58	0.20	1.04		2.57 ***
		(0.73)	(2.28)	(0.39)	(0.22)	(2.85)		(0.77)
(c) Size-INV	*MKT*	0.59 **	-5.26 ***	-0.09	0.10	-1.32		0.51 *
		(0.27)	(1.27)	(0.16)	(0.13)	(1.64)		(0.31)
	SMB	0.02	-1.69 ***	0.11	-0.01	0.05		0.03
		(0.12)	(0.60)	(0.08)	(0.06)	(0.73)		(0.14)
	HML	0.36 *	0.62	0.08	0.13 *	2.10 *		0.48 *
		(0.19)	(0.92)	(0.13)	(0.08)	(1.11)		(0.28)
	UMD	0.38	2.38	0.40	-0.10	-2.25		0.25
		(0.64)	(3.24)	(0.45)	(0.24)	(3.67)		(0.69)
(d) Size-MOM	*MKT*	0.58 **	-5.31 ***	-0.09	0.10	-1.37		0.50
		(0.27)	(1.27)	(0.16)	(0.13)	(1.64)		(0.31)
	SMB	0.12	-1.62 ***	0.12	-0.01	0.09		0.13
		(0.13)	(0.62)	(0.08)	(0.06)	(0.75)		(0.14)
	HML	0.70 *	1.31	-0.07	0.21	2.11		0.81 *
		(0.36)	(2.00)	(0.24)	(0.13)	(1.73)		(0.45)
	UMD	0.97 ***	2.61 **	-0.11	0.03	-0.17		0.95 ***
		(0.22)	(1.06)	(0.13)	(0.10)	(1.33)		(0.22)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using the HP filter (Hodrick, and Prescott, 1997). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A44 Four-factor Model and HP Filter: Japan

Japan								
		const	*GAP*		*TERM*	*DEI*	*UI*	mean
(a) Size-B/M	*MKT*	0.13	-2.22	***	-0.14	0.67	0.03	0.12
		(0.29)	(0.71)		(1.75)	(1.38)	(0.14)	(0.32)
	SMB	0.14	-0.34		0.04	0.31	-0.03	0.15
		(0.17)	(0.44)		(1.08)	(0.85)	(0.09)	(0.18)
	HML	0.19	1.27	***	0.04	0.19	-0.14	0.24
		(0.16)	(0.39)		(1.00)	(0.77)	(0.08)	(0.19)
	UMD	0.77	2.47		3.18	0.02	-0.28	0.88
		(0.66)	(1.58)		(5.46)	(2.84)	(0.28)	(0.68)
(b) Size-OP	*MKT*	0.14	-2.30	***	-0.36	0.68	0.02	0.13
		(0.29)	(0.71)		(1.75)	(1.38)	(0.15)	(0.32)
	SMB	0.22	-0.45		-0.03	0.70	-0.01	0.23
		(0.18)	(0.45)		(1.09)	(0.86)	(0.09)	(0.18)
	HML	-0.48	2.84	***	-0.37	-2.40	-0.18	-0.42
		(0.31)	(0.96)		(2.00)	(1.55)	(0.18)	(0.37)
	UMD	0.56	0.76		-1.22	-1.61	-0.26	0.65
		(0.64)	(2.02)		(4.63)	(3.09)	(0.30)	(0.66)
(c) Size-INV	*MKT*	0.10	-2.36	***	-0.40	0.63	0.03	0.09
		(0.29)	(0.71)		(1.75)	(1.38)	(0.15)	(0.32)
	SMB	0.19	-0.34		-0.09	0.57	-0.03	0.20
		(0.17)	(0.44)		(1.08)	(0.86)	(0.09)	(0.18)
	HML	-0.01	3.58	***	-0.66	-1.11	-0.07	0.02
		(0.24)	(0.71)		(1.77)	(1.15)	(0.12)	(0.36)
	UMD	0.30	2.00		0.25	-1.55	-0.01	0.31
		(0.52)	(1.54)		(3.39)	(2.31)	(0.26)	(0.52)
(d) Size-MOM	*MKT*	0.08	-2.18	***	0.07	0.60	0.04	0.06
		(0.29)	(0.72)		(1.77)	(1.39)	(0.15)	(0.32)
	SMB	0.28	-0.87	*	0.68	0.46	0.01	0.28
		(0.18)	(0.51)		(1.14)	(0.92)	(0.10)	(0.20)
	HML	-0.08	2.69	**	-3.54	1.14	-0.22	0.01
		(0.39)	(1.19)		(3.23)	(1.83)	(0.20)	(0.44)
	UMD	0.10	1.42	**	2.40	-0.33	0.09	0.08
		(0.23)	(0.59)		(1.43)	(1.12)	(0.12)	(0.26)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using the HP filter (Hodrick, and Prescott, 1997). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A45 Four-factor Model and Linear Projection Method: U.S.

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Size-B/M	*MKT*	0.17	-0.45	0.29 **	-0.72 ***	0.09	0.61 ***
			(0.27)	(0.39)	(0.14)	(0.28)	(0.32)	(0.19)
		SMB	0.09	-0.61 **	0.08	-0.15	-0.08	0.21
			(0.19)	(0.28)	(0.10)	(0.19)	(0.22)	(0.14)
		HML	0.19	0.14	0.08	0.23	0.24	0.32 **
			(0.18)	(0.26)	(0.10)	(0.18)	(0.21)	(0.13)
		UMD	0.54	1.13	1.80 ***	-0.30	0.74	3.31 ***
			(1.00)	(1.46)	(0.65)	(0.95)	(1.07)	(1.01)
(b)	Size-OP	*MKT*	0.20	-0.38	0.24 *	-0.76 ***	0.09	0.57 ***
			(0.27)	(0.38)	(0.14)	(0.27)	(0.31)	(0.18)
		SMB	0.11	-0.66 **	0.03	-0.05	-0.06	0.16
			(0.19)	(0.27)	(0.10)	(0.19)	(0.22)	(0.13)
		HML	-0.22	-0.54	0.49 ***	0.27	0.17	0.54 **
			(0.31)	(0.42)	(0.17)	(0.32)	(0.34)	(0.26)
		UMD	1.30	0.93	0.37	0.55	0.47	1.87 ***
			(1.04)	(1.23)	(0.56)	(0.98)	(0.99)	(0.63)
(c)	Size-INV	*MKT*	0.18	-0.41	0.27 *	-0.79 ***	0.07	0.59 ***
			(0.27)	(0.39)	(0.14)	(0.27)	(0.32)	(0.18)
		SMB	0.05	-0.60 **	0.07	-0.04	-0.10	0.15
			(0.19)	(0.28)	(0.10)	(0.19)	(0.22)	(0.13)
		HML	0.39 *	-0.35	0.12	0.18	0.33	0.57 ***
			(0.23)	(0.32)	(0.11)	(0.22)	(0.25)	(0.15)
		UMD	1.18	2.75 **	0.41	-0.42	-1.15	1.81 ***
			(0.90)	(1.34)	(0.46)	(0.92)	(1.04)	(0.70)
(d)	Size-MOM	*MKT*	0.21	-0.42	0.24 *	-0.73 ***	0.07	0.58 ***
			(0.28)	(0.39)	(0.14)	(0.28)	(0.32)	(0.18)
		SMB	0.14	-0.74 **	0.04	-0.08	-0.12	0.21
			(0.21)	(0.29)	(0.10)	(0.20)	(0.23)	(0.14)
		HML	-0.01	-0.23	0.41 **	0.02	0.53 *	0.61 **
			(0.32)	(0.50)	(0.17)	(0.29)	(0.32)	(0.24)
		UMD	0.89 ***	0.75 **	-0.09	0.33	0.26	0.76 ***
			(0.26)	(0.38)	(0.13)	(0.26)	(0.30)	(0.18)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using the linear projection method (Hamilton, 2018). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 US portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A46 Four-factor Model and Linear Projection Method: Europe

Europe								
		const	*GAP*	*TERM*	*DEI*	*UI*		mean
(a) Size-B/M	*MKT*	0.73 ***	-1.56 **	-0.06	0.12	-2.40		0.55 **
		(0.27)	(0.76)	(0.16)	(0.13)	(1.64)		(0.25)
	SMB	0.00	-0.47	0.12 *	0.00	-0.09		-0.01
		(0.12)	(0.36)	(0.08)	(0.06)	(0.72)		(0.12)
	HML	0.16	0.38	0.05	0.06	0.18		0.18
		(0.14)	(0.45)	(0.09)	(0.07)	(0.84)		(0.14)
	UMD	1.50 **	2.17	-0.09	0.18	0.01		1.53 **
		(0.63)	(1.49)	(0.38)	(0.18)	(2.61)		(0.66)
(b) Size-OP	*MKT*	0.75 ***	-1.57 **	-0.06	0.12	-2.44		0.57 **
		(0.28)	(0.76)	(0.16)	(0.13)	(1.64)		(0.26)
	SMB	0.08	-0.51	0.13 *	0.00	-0.15		0.06
		(0.13)	(0.36)	(0.08)	(0.06)	(0.72)		(0.13)
	HML	0.05	0.03	-0.15	0.08	1.62		0.14
		(0.24)	(0.60)	(0.14)	(0.09)	(1.11)		(0.28)
	UMD	2.52 ***	0.76	-0.59	0.20	1.49		2.60 ***
		(0.74)	(1.45)	(0.39)	(0.23)	(2.84)		(0.77)
(c) Size-INV	*MKT*	0.69 **	-1.56 **	-0.05	0.11	-2.41		0.51 **
		(0.27)	(0.76)	(0.17)	(0.13)	(1.64)		(0.25)
	SMB	0.05	-0.49	0.12	0.00	-0.29		0.03
		(0.12)	(0.37)	(0.08)	(0.06)	(0.73)		(0.13)
	HML	0.35 *	0.36	0.08	0.13 *	2.22 **		0.48 *
		(0.19)	(0.64)	(0.13)	(0.08)	(1.11)		(0.26)
	UMD	0.34	2.16	0.46	-0.08	-2.00		0.26
		(0.64)	(2.02)	(0.45)	(0.24)	(3.67)		(0.69)
(d) Size-MOM	*MKT*	0.68 **	-1.63 **	-0.06	0.11	-2.46		0.50 **
		(0.27)	(0.76)	(0.17)	(0.13)	(1.64)		(0.25)
	SMB	0.15	-0.54	0.13 *	-0.01	-0.24		0.13
		(0.13)	(0.38)	(0.08)	(0.06)	(0.75)		(0.14)
	HML	0.66 *	1.58	-0.03	0.23 *	2.32		0.81 *
		(0.37)	(1.15)	(0.25)	(0.14)	(1.73)		(0.45)
	UMD	0.91 ***	1.48 **	-0.10	0.03	0.32		0.95 ***
		(0.22)	(0.63)	(0.13)	(0.10)	(1.31)		(0.22)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using the linear projection method (Hamilton, 2018). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 European portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A47 Four-factor Model and Linear Projection Method: Japan

Japan								
		const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a) Size-B/M	*MKT*	0.10	-0.73 *	-0.10	0.61	-0.03	0.12
		(0.29)	(0.42)	(1.77)	(1.39)	(0.14)	(0.29)
	SMB	0.13	-0.16	0.03	0.29	-0.03	0.15
		(0.17)	(0.25)	(1.08)	(0.85)	(0.09)	(0.18)
	HML	0.20	0.61 ***	0.06	0.27	-0.11	0.24
		(0.16)	(0.23)	(1.01)	(0.77)	(0.08)	(0.19)
	UMD	0.76	0.07	2.44	0.04	-0.17	0.82
		(0.65)	(0.86)	(5.21)	(2.75)	(0.27)	(0.65)
(b) Size-OP	*MKT*	0.10	-0.71 *	-0.31	0.61	-0.05	0.12
		(0.29)	(0.42)	(1.77)	(1.39)	(0.14)	(0.29)
	SMB	0.21	-0.23	-0.04	0.67	-0.02	0.23
		(0.17)	(0.26)	(1.09)	(0.86)	(0.09)	(0.18)
	HML	-0.43	0.91 *	-0.49	-2.33	-0.09	-0.42
		(0.31)	(0.52)	(2.01)	(1.55)	(0.18)	(0.34)
	UMD	0.59	-0.12	-1.63	-1.90	-0.21	0.65
		(0.64)	(1.05)	(4.62)	(3.08)	(0.29)	(0.65)
(c) Size-INV	*MKT*	0.07	-0.75 *	-0.34	0.56	-0.04	0.09
		(0.29)	(0.42)	(1.77)	(1.40)	(0.14)	(0.29)
	SMB	0.19	-0.19	-0.11	0.55	-0.04	0.20
		(0.17)	(0.26)	(1.08)	(0.87)	(0.09)	(0.18)
	HML	0.04	1.56 ***	-0.55	-0.93	0.02	0.02
		(0.24)	(0.42)	(1.78)	(1.15)	(0.12)	(0.34)
	UMD	0.34	0.92	0.57	-1.56	0.04	0.31
		(0.51)	(0.85)	(3.35)	(2.26)	(0.25)	(0.52)
(d) Size-MOM	*MKT*	0.05	-0.69	0.12	0.55	-0.03	0.06
		(0.29)	(0.43)	(1.79)	(1.40)	(0.15)	(0.29)
	SMB	0.27	-0.47	0.64	0.41	-0.01	0.28
		(0.18)	(0.30)	(1.14)	(0.92)	(0.09)	(0.20)
	HML	-0.04	1.59 **	-3.44	1.35	-0.18	0.01
		(0.39)	(0.72)	(3.22)	(1.85)	(0.20)	(0.46)
	UMD	0.12	0.75 *	2.46 *	-0.23	0.12	0.08
		(0.23)	(0.35)	(1.44)	(1.13)	(0.12)	(0.27)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the U.S. output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*) as in Chen et al. (1986), Cooper and Priestley (2011) and Cooper et al. (2022). The output gap is estimated using linear projection method (Hamilton, 2018). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 25 Japanese portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom) and the U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from November 1990 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A48 Four-factor Model and Four Method of the Output Gap Estimation: U.S.

US								
			const	*GAP*	*TERM*	*DEI*	*UI*	mean
(a)	Quadratic	*MKT*	0.59 *	-6.66 **	0.07	-0.84 ***	0.20	0.67 **
			(0.31)	(3.28)	(0.17)	(0.28)	(0.32)	(0.31)
		SMB	-0.16	6.15	-0.10	-0.14	0.34	-0.28
			(0.37)	(4.41)	(0.20)	(0.37)	(0.40)	(0.33)
		HML	-0.31	2.92	0.06	-0.16	0.29	-0.21
			(0.32)	(3.91)	(0.18)	(0.32)	(0.34)	(0.20)
		UMD	0.27	38.71 ***	-0.19	-2.71 *	1.28	0.19
			(0.97)	(14.39)	(0.53)	(1.43)	(1.26)	(1.43)
(b)	Single	*MKT*	0.41	-3.53	0.21	-0.87 ***	0.14	0.67
			(0.29)	(2.15)	(0.14)	(0.28)	(0.32)	(0.64)
		SMB	0.00	3.06	-0.21	-0.11	0.40	-0.27
			(0.34)	(2.92)	(0.17)	(0.37)	(0.40)	(0.58)
		HML	-0.38	5.02 **	0.06	-0.19	0.27	-0.20
			(0.28)	(2.52)	(0.15)	(0.31)	(0.34)	(0.74)
		UMD	1.03	27.19 ***	-0.82 *	-2.65 *	1.57	0.22
			(0.95)	(10.46)	(0.49)	(1.44)	(1.28)	(4.17)
(c)	HP	*MKT*	0.61 **	-3.51 ***	0.04	-0.71 **	0.39	0.67 ***
			(0.29)	(0.81)	(0.15)	(0.28)	(0.32)	(0.24)
		SMB	0.47	-3.34 ***	-0.49 **	0.09	0.74 *	-0.27
			(0.36)	(1.15)	(0.19)	(0.37)	(0.41)	(0.25)
		HML	-0.09	-0.83	-0.08	-0.09	0.41	-0.20
			(0.29)	(0.91)	(0.16)	(0.31)	(0.34)	(0.17)
		UMD	1.68	5.06	-0.97 *	-2.66 *	1.53	0.22
			(1.08)	(3.20)	(0.56)	(1.41)	(1.31)	(0.74)
(d)	LP	*MKT*	0.29	-0.43	0.25 *	-0.86 ***	0.12	0.67 ***
			(0.28)	(0.40)	(0.14)	(0.29)	(0.32)	(0.19)
		SMB	0.19	-0.68	-0.31 *	-0.03	0.52	-0.28
			(0.35)	(0.53)	(0.18)	(0.37)	(0.41)	(0.23)
		HML	-0.15	-0.37	-0.04	-0.09	0.37	-0.20
			(0.29)	(0.42)	(0.15)	(0.31)	(0.34)	(0.17)
		UMD	2.03 *	2.90 *	-1.16 **	-2.69 *	1.70	0.27
			(1.07)	(1.54)	(0.53)	(1.42)	(1.35)	(0.70)

Notes: This table presents price of risk parameter estimates using Equation (4) proposed by Adrian et al. (2015). The output gap is estimated using the linear and quadratic trends, the single trend, the HP filter (Hodrick, and Prescott, 1997), and linear projection method (LP, Hamilton, 2018). The last column indicates the average price of risk. Heteroskedasticity robust standard errors are reported in parentheses. Test assets are 30 US industry portfolios. The U.S. one-month Treasury-Bill yield is used as the risk-free rate. The sample period extends from October 1963 to July 2020. The asterisks *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

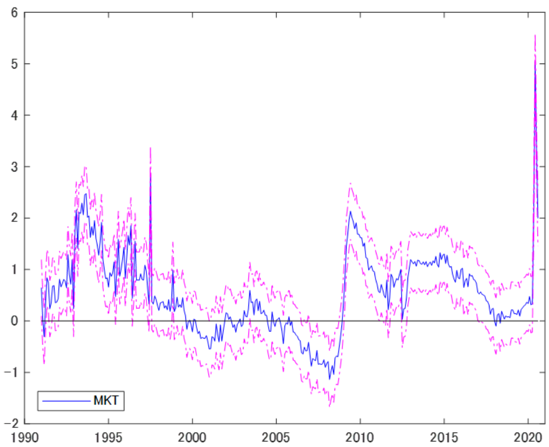
Table A49 Results of Different Output Gap Estimation Methods

Panel A: US	5% *GAP*	10% *GAP*
MKT	14/20	14/20
SMB	9/20	9/20
HML	3/20	4/20
UMD	7/20	14/20
Panel B: Europe	5% *GAP*	10% *GAP*
MKT	12/16	12/16
SMB	4/16	4/16
HML	3/16	3/16
UMD	3/16	5/16
Panel C: Japan	5% *GAP*	10% *GAP*
MKT	12/16	15/16
SMB	5/16	9/16
HML	12/16	14/16
UMD	1/16	2/16

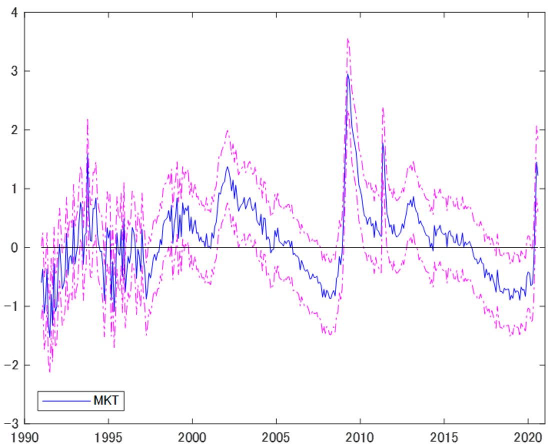
Notes: This table summarises different output gap estimation methods and test portfolio results. We focus on the four factor model. The output gap estimation methods include the linear and quadratic trends, the single trend, the HP filter (Hodrick, and Prescott, 1997), and linear projection method (LP, Hamilton, 2018). Test assets are 25 portfolios sorted by size and book-to-market (Size-B/M), size and operating profitability (Size-OP), size and investment (Size-Inv) and size and momentum (Size-Mom). The U.S. results also employ 30 industry portfolios. The left column indicates the number of the results that corresponding price of risk parameter is statistically significant at the 5% (left) and the 10% (right) levels. For instance, the upper left 14/20 demonstrates that 14 out of 20 parameters are statistically significant at the 5% level.

Figure A1 Time-varying price of market risk: Europe and Japan

Panel A: Europe



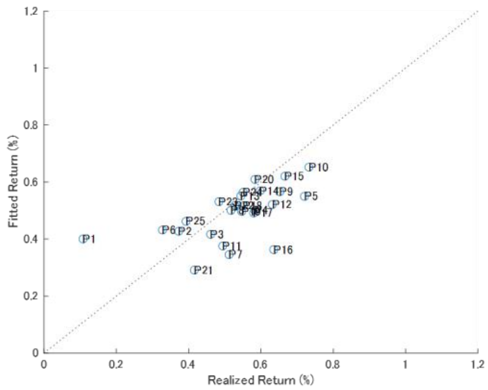
Panel B: Japan



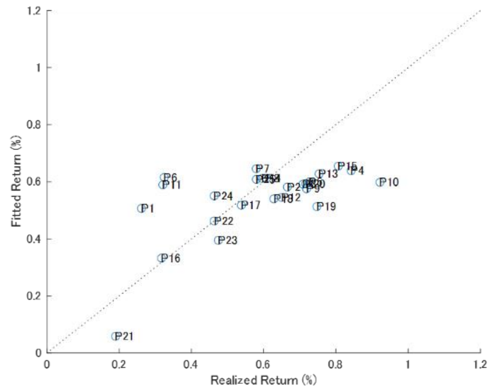
Notes: This figure displays the time-varying price of market risk (*MKT*), $\Lambda_{1,mkt} S_{gap,t}$ with 95% confidence intervals. The price of risk is estimated using Equation (4). The test portfolio is 25 European (Panel A) or Japanese (Panel B) portfolios sorted by size and book-to-market (Size-B/M).

Figure A2 Comparison of pricing errors: Europe

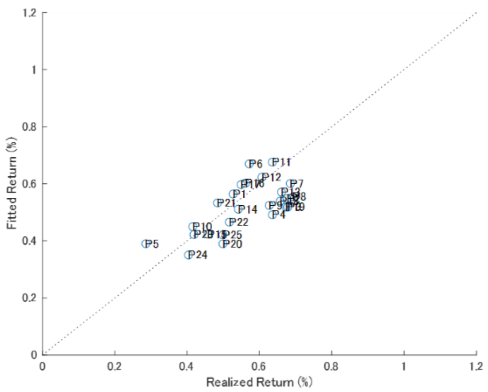
Panel A: Size-B/M



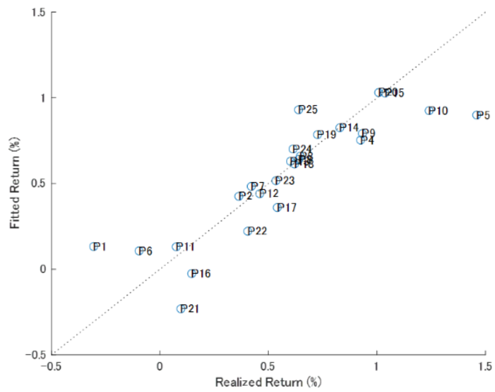
Panel B: Size-OP



Panel C: Size-Inv



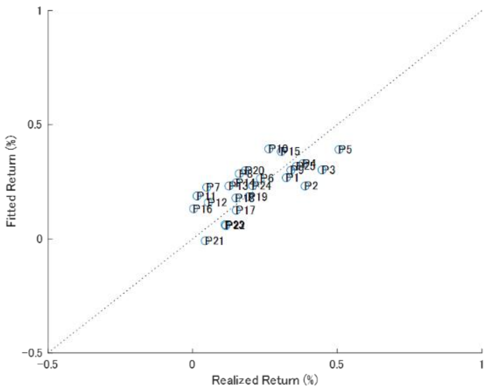
Panel D: Size-Mom



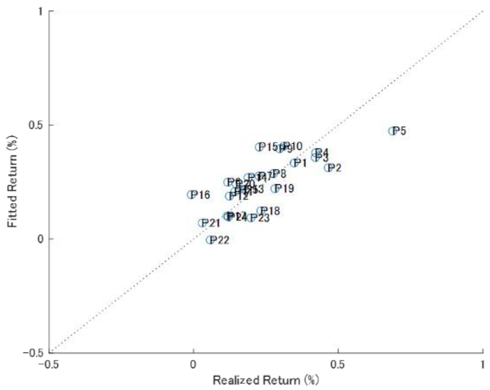
Notes: This figure displays the comparison of pricing errors for European portfolios. The realized mean excess returns are on the horizontal axis and the mean fitted excess returns are on the vertical axis. The fitted excess returns are estimated by Equation (4). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*).

Figure A3 Comparison of pricing errors: Japan

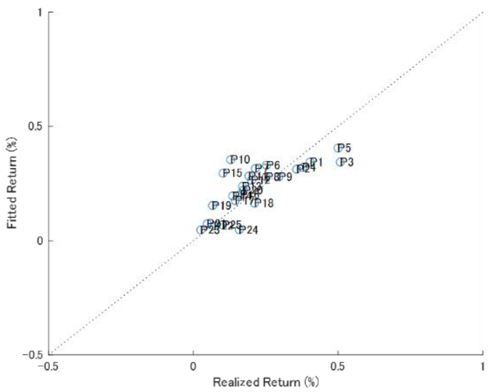
Panel A: Size-B/M



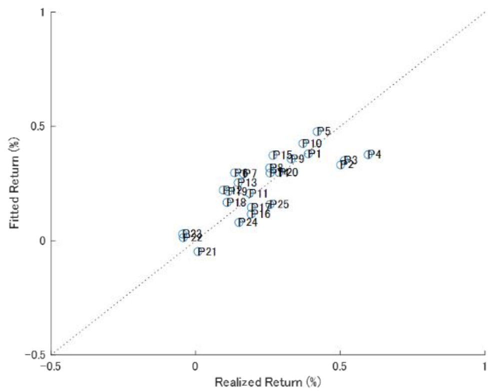
Panel B: Size-OP



Panel C: Size-Inv



Panel D: Size-Mom



Notes: This figure displays the comparison of pricing errors for Japanese portfolios. The realized mean excess returns are on the horizontal axis and the mean fitted excess returns are on the vertical axis. The fitted excess returns are estimated by Equation (4). The risk factors include the market (*MKT*), size (*SMB*), value (*HML*) and momentum (*UMD*), as proposed by Fama and French, (1992, 1993) and Carhart, (1997). The state variables are the output gap (*GAP*), term spread (*TERM*), unexpected inflation (*UI*), and change in expected inflation (*DEI*).