The International Commonality of Idiosyncratic Variances

Geert Bekaert

Xue Wang

Xiaoyan Zhang *

October 2021

Abstract

We document strong global commonality in country- and firm-level idiosyncratic return variances across 23 developed markets, and develop a dynamic pricing model to interpret the empirical pattern. The global common factor of idiosyncratic return variances is highly correlated with that of idiosyncratic cash flow variances, and is also significantly related to variables capturing aggregate discount rate variation and growth opportunities. Furthermore, aggregate idiosyncratic return and cash flow variances are predominantly but not always countercyclical. Our evidence is mostly inconsistent with extant theories regarding the time variation in idiosyncratic return variances.

JEL Classification: F39, G12, G15
Keywords: return idiosyncratic variance, cash flow idiosyncratic variance, global commonality, countercyclical, state variables.

*Bekaert is affiliated with Columbia Business School and the NBER. Wang is with School of Finance, Nankai University. Zhang is with PBC School of Finance, Tsinghua University. Contact information: Bekaert, gb241@columbia.edu; Wang, xuewang@nankai.edu.cn; Zhang, zhangxiaoyan@pbcsf.tsinghua.edu.cn. We thank Anna Lopatnikova, Lubos Pastor, Steven J. Riddiough, Stijn Van Nieuwerburgh, Pietro Veronesi, and seminar participants at the Australasian Finance and Banking Conference, the Chinese Finance Annual Meeting, the Finance Down Under Conference, and Tsinghua University for useful comments.

The International Commonality of Idiosyncratic Variances

Abstract

We document strong global commonality in country- and firm-level idiosyncratic return variances across 23 developed markets, and develop a dynamic pricing model to interpret the empirical pattern. The global common factor of idiosyncratic return variances is highly correlated with that of idiosyncratic cash flow variances, and is also significantly related to variables capturing aggregate discount rate variation and growth opportunities. Furthermore, aggregate idiosyncratic return and cash flow variances are predominantly but not always countercyclical. Our evidence is mostly inconsistent with extant theories regarding the time variation in idiosyncratic return variances.

JEL Classification: F39, G12, G15
Keywords: return idiosyncratic variance, cash flow idiosyncratic variance, global commonality, countercyclical, state variables.

1. Introduction

Idiosyncratic return variances represent the uncertainty in stock returns that cannot be explained by systematic risk factors. Apart from their obvious importance in finance for risk management and asset allocation decisions, there has been a resurgence of interest in the dynamics and economic effects of idiosyncratic variances in economics as well. For example, Bartram, Brown, and Stulz (2012) and Brown and Kapadia (2007) link idiosyncratic volatility to financial development over time and across countries. A rapidly growing macroeconomic literature, such as Bloom (2009) and Christiano, Motto, and Rostagno (2014), studies the effect of uncertainty shocks on real economic activity and business cycles, and document that heightened uncertainty can entail economic slowdowns through delayed firm investments, or increased precautionary savings by households.

While macroeconomists often employ stock market data to measure uncertainty, they take various short-cuts by using aggregate market volatility or measures of cross-sectional dispersion (see e.g. Bloom (2009)). However, the economic models call for a measure of *idiosyncratic* variance, reflecting non-systematic volatility, and, better still, a measure of firm-specific productivity or output uncertainty. The focus of this article is to analyze the dynamics, determinants, and commonality of idiosyncratic return and cash flow variances in 23 developed markets using firm-level stock return and cash flow data. As our key empirical finding, we document an important global component in the country- and firm-level uncertainty measures for returns. Furthermore, we propose a dynamic pricing model to identify the economic sources behind the global commonality of idiosyncratic return variances, finding idiosyncratic cash flow variances to be the most important determinant.

We start by documenting strong commonality in country idiosyncratic return variances across 23 developed markets. For the G7 countries, for example, the average correlation of country idiosyncratic return variances is 66.6%, which is even higher than the average correlation of country level market returns for the same set of countries of 58.6%. Given that idiosyncratic variances by definition reflect "non-systematic" variation, the evidence of commonality in idiosyncratic variances itself is surprising. Computing the *global* idiosyncratic variance as the value-weighted average of country idiosyncratic return variances, it explains, on average, more than 50% of the country idiosyncratic variances.

Next, we find that within each country, firm-level idiosyncratic return variances also exhibit strong commonality, thereby extending Duarte, Kamara, Siegel, and Sun (2014) and Herskovic, Kelly, Lustig, and Van Nieuwerbugh (2016), who identify a common factor in the idiosyncratic volatility of individual U.S. firms. In addition, we show that the global idiosyncratic variance has substantial explanatory power for firm idiosyncratic variances beyond that of the country idiosyncratic return variance.

Given the importance of the global idiosyncratic variance in capturing commonality in country and firm level idiosyncratic variances, we propose and estimate a pricing model to interpret the empirical dynamics of this global uncertainty measure. Our model is in the tradition of dynamic valuation models such as Ang and Liu (2004) and Bakshi and Chen (2005), featuring stochastic discount rates and cash flow growth rates, but incorporates stochastic volatility in their data generating processes. To be specific, the model features six state variables: the aggregate discount rate and its conditional variance, the aggregate cash flow growth and its conditional variance, a measure of growth opportunities, and the global idiosyncratic cash flow variance. These six variables span both systematic and idiosyncratic return risk at the global level.

We use return on equity (ROE) as the key cash flow variable, and propose a new methodology to compute a firm's idiosyncratic cash flows and its variance. We compute the country and global idiosyncratic cash flow variances as the value-weighted average of firm idiosyncratic cash flow variances in the country or the global market, respectively. We show separately that there is also an important common global component in both country- and firm-level idiosyncratic cash flow variances in all 23 countries, represented by the global idiosyncratic cash flow variance measure.

The six state variables together explain a substantial part of the time-series variation of aggregate idiosyncratic variances, with a linear model delivering an adjusted R^2s of 59.5%. The global idiosyncratic cash flow variance by itself explains 26.5% of the variation in global idiosyncratic return variances, which is the most important determinant among all state variables. The discount rate also explains a non-trivial fraction of the variation in aggregate idiosyncratic return variances. We use the conditional market variance to empirically help span discount rate and aggregate cash flow uncertainty in the model. Confirming results for the U.S. in Bekaert, Hodrick, and Zhang (2012) and Bartram, Brown, and Stulz (2017), this variable also accounts for a substantial fraction of the variation in the global idiosyncratic return variance.

Finally, we examine the cyclical properties of the global idiosyncratic return and cash flow variances. We find them to be predominantly but not always countercyclical. In particular, the global idiosyncratic variances are negatively correlated with GDP growth, which indicates counter-cyclicality, before 1997 and after 2005; while they are positively correlated during the internet bubble period of 1997 to 2005, indicating cyclicality.[1] The statistical evidence for overall

[1] This is consistent with the empirical results in Dew-Becker and Giglio (2021) regarding a measure of cross-sectional uncertainty constructed from stock options on individual firms, which also peaks during the dot com boom and the Great Financial Crisis but was mostly acyclical.

countercyclicality at the global level is strong for cash flow but weaker for return variances. At the country level, there is more uniform evidence in favor of countercyclicality. The finding of counter-cyclicality is inconsistent with the models in Cao, Simin, and Zhao (2008) and Pastor and Veronesi (2003, 2006), which imply that idiosyncratic volatility is procyclical. However, it echoes the recent macro literature suggesting a negative link between uncertainty and future economic activity.

Our work relates to a large literature attempting to explain the dynamics of idiosyncratic return variances. In terms of empirical studies, Guo and Savickas (2008) and Bekaert, Hodrick, and Zhang (2012) investigate the time-series dynamics of international aggregate idiosyncratic variances, but neither study examines their commonality in the global market. Theoretical research on idiosyncratic variances includes Cao, Simin, and Zhao (2008) and Pastor and Veronesi (2003, 2006). The former proposes a simple model in which idiosyncratic volatility is related to the growth options available to managers and the authors argue that aggregate idiosyncratic volatility is related to the level and variance of these growth options. Our growth opportunity findings confirm the Cao, Simin, and Zhao (2008) results for the U.S., but our growth opportunity measure is constructed differently and we verify that it indeed predicts future earnings growth. Alternatively, Pastor and Veronesi (2003, 2006) formulate asset pricing models with learning in which uncertainty about a firm's profitability increases idiosyncratic uncertainty and risk, suggesting a large role for cash flow uncertainty in explaining idiosyncratic return variances as do we.

In comparison with the previous literature, our main contribution is twofold. First, we empirically establish the existence of an important global common component of country- and firm-level idiosyncratic return variances. Second, we propose a pricing model to interpret the time variation in this global return common component, and find that it is intuitively connected to variation in global cash flows. Thus, any theoretical explanation of the dynamics of idiosyncratic return variances must account for an important global component in both idiosyncratic return variances and cash flow variances.

The paper is organized as follows. We introduce the data in Section 2. Section 3 establishes the commonality of idiosyncratic return variances. A pricing model is proposed to explain the dynamics of the global commonality in idiosyncratic return variances in Section 4. Section 5 presents model estimation results and examines whether the model can explain the global commonality in idiosyncratic return variances. We investigate the cyclicality of idiosyncratic return and cash flow variances in Section 6. Section 7 concludes.

2. Data

2.1 Sample

Our sample covers 23 MSCI developed markets during a sample period from January 1980 to December 2017. For U.S. firms, we obtain return data from CRSP and accounting data from Compustat. For non-U.S. firms, we obtain returns and market values in USD from Datastream and accounting data from Worldscope.[2] We apply the following filters to the data: 1) We remove firm-quarters with market capitalization below USD 5 million at the quarter end[3]; 2) We remove firm-quarters with negative total assets at the quarter end; 3) We remove firm-days with daily returns lower than -100% or higher than 200%, and if the return on date t is greater than 100% (lower than -50%) and the return on day $t+1$ is lower than -50% (greater than 100%), then both days are

[2] The data coverage starts later for Finland (1987), Israel (1992), New Zealand (1986), Portugal (1988), Spain (1986), and Sweden (1982).

[3] While this screen retains some micro-cap firms, the median market capitalization of international firms tends to be smaller than that of firms in the U.S. (see Table 1). Because our results are based on value-weighted measures, the inclusion of relatively small firms does not significantly affect our results.

eliminated, in a similar spirit to the filters proposed by Ince and Porter (2006) for monthly returns; 4) We remove firm-quarter ROEs with non-positive book value of common equity or ROEs below -100%, following Vuolteenaho (2002); 5) We winsorize firm-quarter book-to-market (B/M) ratios and ROEs by country, at the 1% and 99% levels.

Summary statistics for our sample firms are reported in the first two columns of Table 1. For each developed market, we present the time-series average of the number of publicly listed firms, and the time-series average of the cross-sectional medians of market capitalization from the firm-quarter panel. Japan, the U.K., and the U.S. have the largest number of firms, with each having over 1,000 publicly listed firms, whereas four countries including Austria, Ireland, New Zealand, and Portugal have fewer than 100 public firms. The average median firm market capitalizations range between \$98 million (Denmark) and \$544 million (Spain).

2.2 Defining Idiosyncratic Return Variances

To compute firm-level idiosyncratic return variances, we need to remove systematic risk from stock returns. Bekaert, Hodrick, and Zhang (2009) examine different asset pricing models and find that the best performing model for describing comovements among international asset returns is the world-local Fama-French (1996) factor model, which includes market, size, and value factors from global and local capital markets. Therefore, we estimate the following specification using daily returns in excess of the risk-free rate, *exret*, for each firm *i* within each quarter q:

$$exret_{it} = \alpha_{iq} + \beta_{iq}^{WMKT} WMKT_t + \beta_{iq}^{WSMB} WSMB_t + \beta_{iq}^{WHML} WHML_t$$
$$+\beta_{iq}^{MKT} MKT_t + \beta_{iq}^{SMB} SMB_t + \beta_{iq}^{HML} HML_t + u_{it}, \quad t \in q. \tag{1}$$

The variables WMKT/MKT, WSMB/SMB, and WHML/HML are the global/country level market, size, and value factors, respectively. For each country, we calculate MKT as the value-weighted return of all firms in the country. To obtain SMB, we sort all firms in each country into three size groups at the end of each June of year *y*. The country size factor, SMB, for July of year *y* to June of *y+1* is computed as the value-weighted return difference between firms in size group 1 (smallest 1/3 firms) and size group 3 (largest 1/3 firms). Similarly, the country value factor, HML, for July of year *y* to June of year *y+1* is computed as the value-weighted return difference between firms in B/M group 3 (1/3 firms with the highest BM ratios) and B/M group 1 (1/3 firms with the lowest BM ratios), where B/M is calculated using the book equity for the last fiscal year end in year *y-1* and market value at the end of December of year *y-1*. The global variables WMKT, WSMB, and WHML are computed as the value-weighted averages of the country level factors. This model setup allows for time-varying exposures to global and local factors, potentially reflecting changes in the degree of financial integration over time. After estimating equation (1) for each firm each quarter, we obtain the time series of firm-specific residuals, u_{it}. We calculate the idiosyncratic return variance, $IVRET_{iq}$, as the variance of the residual term in equation (1), u_{it}, for firm *i* in each quarter *q*:

$$IVRET_{iq} = \frac{1}{T-1} \sum_{t \in q} u_{it}^2, \quad (2)$$

where T is the number of days in the quarter. All return variance measures are annualized by multiplying by 250, and we delete the top 1% observations in each country to mitigate the potential effect of outliers.

We report the time-series average of the cross-sectional medians of IVRET in each country in Table 1, Column III. Across all countries, the average median of IVRET is 0.078. By country, the highest value is observed for Canada at 0.145, and lowest for Belgium and Switzerland at 0.043. The U.S. median is at 0.135, which is relatively high, compared to other countries.

Goyal and Santa-Clara (2003) find that the U.S. aggregate idiosyncratic return variance, calculated as the cross-sectional average of firm-level idiosyncratic return variances, serves as an important state variable, because it predicts the return on the U.S. market. We define country-level idiosyncratic variance, $IVRET_q^C$, for country C in quarter q, as the value-weighted average of the firm-level $IVRET_{iq}$ within the country. The time-series averages of the country idiosyncratic variance measures are reported in the last column of Table 1. Across 23 developed markets, the average country IVRET is 0.050; the country IVRETs range between 0.028 (Switzerland) and 0.072 (Japan). The U.S. IVRET is 0.069, which is the second highest value.

Figure 1, Panel A plots the IVRET time series for Germany, Japan, the U.K., and the U.S. There is substantial time variation in country IVRETs with two noticeable peaks around 2001 and 2008, suggesting high IVRETs are more likely to happen around recessions. The plot also presents some preliminary evidence that country IVRETs tend to move together over time.

Finally, we compute a global idiosyncratic variance measure, $IVRET_q^G$, as the value-weighted average of country level $IVRET_q^C$. In Figure 1, Panel B, we present the time-series pattern for global IVRET, together with NBER recession indicators. There are again two peaks around the recessions in 2001 and 2008, but note that the variable is already elevated during the dot com boom and peaks before the 2001 recession. Global IVRET has a mean of 0.063, and a standard deviation of 0.036.

3. Commonality in Idiosyncratic Return Variances

In this section, we examine the commonality in idiosyncratic return variances in 23 developed markets. Section 3.1 documents that country idiosyncratic return variances exhibit commonality, and how the global idiosyncratic return variance helps capture it. Section 3.2

examines the common component in firm-level idiosyncratic return variances within each of the developed markets.

3.1 Commonality in Country Idiosyncratic Return Variances

To measure potential commonality among country IVRETs, we calculate the pairwise correlations of each country's IVRET with the IVRET of each of the other countries, and report the average. For comparison, we also compute the average pairwise correlations for market returns of these countries. Both are reported in Table 2, Columns I and II, respectively.

Across all countries, the average pairwise correlation of idiosyncratic variances is 0.633, slightly higher than the average pairwise correlation of returns at 0.583. The idiosyncratic variance correlations are on average higher than return correlations in 21 countries, and lower in only two countries. In the case of the U.S., the average correlation with other country's IVRET is 0.661, while the average correlation with other country's market portfolio returns is 0.606. Thus, comovement among country idiosyncratic variances and the U.S. idiosyncratic variance is of the same order of magnitude as comovements among country returns and the U.S. return. Given that the return residuals themselves are uncorrelated with the local and global return factors, it is surprising to see such high cross-country correlations in their second moments. One simplistic explanation for the strong explanatory power of the global idiosyncratic variance is that the existing factor models used to remove systematic components from returns are missing an internationally correlated risk factor which features conditional heteroskedasticity. However, the results are robust to alternative models to remove systematic risks, and after removing the common risk factors, the residual returns themselves show no correlation across countries. On average, the pairwise correlation is only 0.037.

Can this surprising comovement in country idiosyncratic variances across countries be captured by the global idiosyncratic variance? To answer this question, for each country C, we project its idiosyncratic return variance, $IVRET_q^C$, on the global counterpart, $IVRET_q^G$, as follows:

$$IVRET_q^C = \alpha_C + \beta_C IVRET_q^G + \varepsilon_q^C. \quad (3)$$

We report the β_C coefficients and R^2s for these regressions in Columns III-V of Table 2, Panel A. All country level idiosyncratic variances load positively on the global measure, with coefficients ranging between 0.169 and 1.266, with the average coefficient being 0.626. All coefficient t-statistics (except Austria's and Israel's) are highly significant. The average adjusted R^2 for individual country regressions is 0.548, indicating that the global idiosyncratic variance accounts for a large part of each country's IVRET. The β_C and R^2 results imply that the global IVRET is an important factor explaining the commonality of country IVRETs.

As another test of the global IVRET's ability to capture the comovement of country IVRETs, the pairwise correlations of ε_q^C should be substantially lower than the pairwise correlations of country IVRETs. In Column VI, we present the pairwise correlations of the residual ε_q^C. While the original correlations of IVRETs are on average 0.633, the average correlation of these residuals across all countries falls to 0.229.

A popular approach to find commonality among time-series is principal component (PC henceforth) analysis. Because not all countries have data covering 36 years, we divide the sample period into three equal non-overlapping periods (1982-1993, 1994-2005, and 2006-2017) and perform the PC analysis for each subperiod. Panel B of Table 2 shows the time-series average of the explained variation for the first 5 principal components of the country IVRETs. The first PC, the most important driver of commonality, explains 70.1% of the cross-country variation of idiosyncratic return variances, indicating they exhibit a factor structure. The global IVRET has a correlation of 0.929 with the first PC, which also indicates that the global IVRET captures a large part of the commonality of country IVRETs. It also has a 0.204 correlation with the third PC, but that PC only explains 5.6% of country IVRET variation.

3.2 Commonality in Firm-Level Idiosyncratic Return Variances

Our strong evidence of commonality in country idiosyncratic variances can potentially shed new light on recent intriguing results regarding commonality among firm idiosyncratic return variances. Using U.S. data, Duarte et al. (2014) and Herskovic et al. (2016) identify an important common factor in firm-level idiosyncratic return volatilities. Our results suggest a global factor may be partially responsible for this commonality.

A necessary condition for this to be true is that the pattern documented in Duarte et al. (2014) and Herskovic et al. (2016) is present in most other countries. To find out, we first conduct a principal component analysis using all firm-level IVRETs within each country in each 12-year subperiod. We report the summary statistics of the within-country PC analysis in Table 3, Panel A. In Column I, we present the time-series average of the percentage of overall variance explained by the first PC within each country over the three subperiods. For the U.S., the first PC explains 33.2% of the variation across firm-specific IVRETs. Duarte et al. (2014) use the log of monthly idiosyncratic volatility and find that the first common component explains a third of the variation, which is comparable to our results. Herskovic et al. (2016) regress annual idiosyncratic volatility on the equally weighted average (likely highly correlated with the first PC), finding an R^2 of 0.35. For all 23 countries, this number varies between 26.3% for France and 61.3% for Ireland, and the average across countries is 38.7%. Thus the factor structure documented in Duarte et al. (2014) and Herskovic et al. (2016) is not unique to the U.S. but widespread across developed markets.

It is natural to ask what is behind the commonality among firm idiosyncratic return variances, documented by the PC analysis. Is this commonality also driven by the global idiosyncratic variance? To answer this question, for each firm *i* in country *C,* we project the firm-level idiosyncratic variance, $IVRET_{iq}$, onto both country and global idiosyncratic variances as follows:

$$IVRET_{iq} = \alpha_i^G + \beta_i^C \; IVRET_q^C + \beta_i^G \; IVRET_q^G + \varepsilon_{iq}^G, i \in C \; . \tag{4}$$

For comparison, we also run regressions using only $IVRET_q^C$ as the independent variable.

For the latter regression, we report the median adjusted R^2 across all firms within each country in Table 3, Columns II. The average median adjusted R^2 across countries is 0.135, when we only use the country idiosyncratic variance, which just reflects the within-country commonality already showing up in the PC analysis. We show the median adjusted R^2 of the regression (4) in Column III. The addition of the global idiosyncratic variance increases the R^2 to 0.185 on average. Clearly, the commonality of idiosyncratic variances at the firm level, within the country, is driven by both global and country idiosyncratic variances, with the former increasing the explanatory power by about 50% relative to the country idiosyncratic variance.

Given the within-country commonality evidence, it is natural to ask whether there is commonality in firm idiosyncratic return variances *across countries*? To examine this issue, we estimate principal components for all firms across countries in our sample. Summary statistics on the PC analysis are reported in Table 3, Panel B. The first PC explains about 25.3% of the variation in firm IVRETs across countries. The first three PCs added together explain 41% of the variation of firm IVRETs. Clearly, there is substantial global comovement among firm-level IVRETs. To verify whether this commonality can be captured by the global idiosyncratic variance, we compute the correlations between the PCs and global IVRET. The correlation between the first PC, the most important commonality variable, and the global IVRET is 0.705; and the global IVRET is also nontrivially correlated with the second PC. This confirms that the global IVRET captures the commonality among firm level IVRETs.

To summarize this section, we document strong commonality in country-level idiosyncratic return variances and in firm-level idiosyncratic return variances within and across countries. We provide new evidence that the global idiosyncratic return variance is an important determinant of these commonalities. This fact naturally steers us towards a global pricing model to explain the determinants of the global idiosyncratic return variance.

4. A Pricing Model for Explaining Commonality in Idiosyncratic Return Variances

In this section, we sketch a dynamic pricing model to help interpret the dynamics of the global idiosyncratic return variance. The model is designed to be simple and tractable, and connect the global idiosyncratic return variance to aggregate and firm-specific variability of earnings growth, time-varying expected earnings growth, and time-varying discount rates, in the tradition of dynamic stock valuation models such as Ang and Liu (2004), Bakshi and Chen (2005), and Bekaert and Harvey (2000). Relative to extant dynamic valuation models, both the discount rate and cash flow process are more elaborate to accommodate time-varying volatility. The model further includes a growth opportunity variable distinct from other cash flow growth variables, as in Cao, Simin, and Zhao (2008).

We do make the simplifying assumption that firms operate in an integrated world economy. While a hybrid model with both local and global factors may be preferred, our previous results in Section 3 suggest that the global factor tends to be dominant and explains a large portion of aggregate idiosyncratic return variances in all 23 countries. We therefore focus our attention on explaining variation in this global idiosyncratic return variance. In addition, instead of calibrating the model fully and solving for price earnings ratios and endogenous returns, we only use the model implication that the dynamics of global idiosyncratic return variances depend on all state variables and employ a regression framework to estimate the relation.

We describe the global aggregate environment in Section 4.1, model dynamics at the firm level in Section 4.2, and discuss the model implications in Section 4.3. The technical details and more extensive motivation are provided in the Appendix. Readers not interested in the technical details of the model can skip to Section 4.3.

4.1 The Aggregate Environment

The global economy features an aggregate discount rate (ADR), a discount rate variance variable (ADRV), an aggregate growth opportunity (AGO), an aggregate earnings or cash flow process (AE), as well as aggregate uncertainty about earnings or cash flow shocks measured by their volatility (AEV). We use "A" to denote aggregate variables and "F" to denote firm level variables. The model consists of standard dynamic processes for discount rates and cash flows, while incorporating time-varying volatilities. One can view the model as a dynamic version of the Gordon growth model, thus there is no explicit pricing kernel.

We start with the discount rate, ADR. The time variation in ADR is driven partially by aggregate cash flow uncertainty, AEV, and partially by pure discount rate shocks, ε_{ADR}, which can be attributable to changes in sentiment, or economically motivated changes in aggregate risk aversion (see Bekaert, Engstrom, and Xu (2021) for more discussion)). The conditional mean of the discount rate features an autoregressive term, but also depends on AEV. The discount rate's conditional variability depends on both aggregate cash flow uncertainty and discount rate specific volatility, $ADRV$:

$$ADR_t = \mu_{ADR} + \rho_{ADR} ADR_{t-1} + \phi_{ADR,AEV} AEV_{t-1}$$

$$+\sigma_{ADR}\sqrt{ADRV_{t-1}}\varepsilon_{ADR,t} + \sigma_{ADR,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t}. \quad (5)$$

All shocks (ε's) in the model follow independent N (0,1) distributions.

The discount rate specific uncertainty, *ADRV*, follows a simple autoregressive square root process:

$$ADRV_t = \mu_{ADRV} + \rho_{ADRV} ADRV_{t-1} + \sigma_{ADRV}\sqrt{ADRV_{t-1}}\varepsilon_{ADRV,t}. \quad (6)$$

The aggregate cash flow uncertainty, *AEV*, follows a square root process as well. The conditional mean of aggregate cash flow uncertainty has an autoregressive component, but also depends on a growth opportunity state variable, *AGO*, as suggested by Cao, Simin, and Zhao (2008)[4]:

$$AEV_t = \mu_{AEV} + \rho_{AEV} AEV_{t-1} + \phi_{AGO} AGO_{t-1} + \sigma_{AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t}. \quad (7)$$

The growth opportunity variable, *AGO*, is modeled as a first order autoregressive process:

$$AGO_t = \rho_{AGO} AGO_{t-1} + \sigma_{AGO}\varepsilon_{AGO,t}. \quad (8)$$

Of course, growth options should, by definition, increase earnings growth in the future when they are realized, and thus, growth options should affect expected earnings growth. We first define aggregate earnings growth, *AEG*, as follows:

$$AEG_t = ln\frac{EA_t}{EA_{t-1}}, \quad (9)$$

where EA is total earnings. Then we model the conditional mean of aggregate earnings growth, *AEG*, as driven by *AGO* and the one-period lagged aggregate ROE, *AROE*, measured as net income divided by book equity. This assumption follows a long tradition in the accounting literature (Nissim and Ziv, 2001). In this study, we choose ROE as the key cash flow variable, because

[4] They rely on the standard intuition that a firm's equity is a call option on the firm's assets, giving a firm's manager an incentive to increase the variance of the firm. The manager can do so by selecting investments with the most non-systematic risk from the opportunity set. That is, while assets in place generate a particular conditional variance of future cash flows, the arrival of a growth option adds to the uncertainty of the future cash flows, thus increasing the conditional variability of the firm's future cash flows. We assume such a mechanism at the aggregate level.

earnings growth rates can be quite noisy, especially at firm level. In the earnings growth model, ROE naturally captures the profitability of assets in place:

$$AEG_t = \mu_{AEG} + \phi_{AEG,AROE} AROE_{t-1} + \phi_{AEG,AGO} AGO_{t-1}$$

$$+\sigma_{AEG}\, \varepsilon_{AEG,t} + \sigma_{AEG,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t}. \tag{10}$$

Note that the time-variation in earnings variance is driven by *AEV* but there is also a homoskedastic shock.

The conditional mean of *AROE* depends on its own past, the aggregate discount rate, and the growth opportunity variable. Moreover, its conditional variance depends on cash flow uncertainty:

$$AROE_t = \mu_{AROE} + \rho_{AROE} AROE_{t-1} + \phi_{AROE,ADR} ADR_{t-1} + \phi_{AROE,AGO} AGO_{t-1}$$

$$+\sigma_{AROE}\varepsilon_{AROE,t} + \sigma_{AROE,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t} \tag{11}$$

Note that *AEV* spans time variation in the conditional variance of both *AEG* and *AROE* and thus captures time variation in aggregate cash flow uncertainty.

Altogether, there are five state variables in total that we collect in the state vector $X_t = [ADR_t, ADRV_t, AGO_t, AROE_t, AEV_t]'$.

4.2 Modeling Firms

Firms differ from one another because they have different sensitivities to the aggregate state variables we introduced, and also face idiosyncratic uncertainty about their cash flows with time-varying volatility FV_i, which follows a square root process:

$$FV_{it} = (1-\rho_i)\mu_i + \rho_i FV_{it-1} + \sigma_i\sqrt{FV_{it-1}}\varepsilon_{FV,it}. \tag{12}$$

Given the aggregate pricing environment, a firm is characterized by three main "systematic" exposures: its discount rate exposure, its cash flow exposure, and its aggregate volatility exposure. Specifically, for firm *i*, the firm discount rate, FDR_i, follows:

$$FDR_{it} = (1 - \beta_i)r_f + \beta_i ADR_t, \tag{13}$$

which is a version of the conditional CAPM, assuming a constant interest rate.

Furthermore, the firm-specific earnings growth rate, FEG_i, follows:

$$FEG_{it} = \gamma_i AEG_t + \sqrt{FV_{it-1}}\varepsilon_{FEG,it}. \tag{14}$$

By modelling the cash flow exposure this way, the γ coefficient captures both exposures to the cash flow level variable and cash flow variability, *AEV*. Therefore, a firm is characterized by just two "systematic" exposures: discount rate exposure, β, and cash flow exposure, γ. Because firm-specific cash flow uncertainty varies through time, it affects the firm's valuation ratios and firm-specific return volatility. It would be trivial to allow additional exposures, but this simple model suffices to generate meaningful dynamics for aggregate idiosyncratic earnings variability.

4.3 Model Solution and Implications

In the Appendix, we show that, given normally distributed shocks, a firm's price earnings ratio is the infinite sum of exponentiated affine functions of the state variables, that is, the five aggregate state variables, and idiosyncratic cash flow variability. Return expressions then follow straightforwardly. In our model, an increase in idiosyncratic cash flow variability increases prices. This is analogous to Pastor and Veronesi (2003, 2006)'s result that the market to book ratio of a firm is increasing in idiosyncratic uncertainty because of the convex relation between future payoffs and variability. However, our model also features time-varying aggregate uncertainty; an increase in aggregate uncertainty may directly increase discount rates and therefore decrease prices. With both effects present, the model is potentially consistent with the simultaneous occurrence of high levels of idiosyncratic variability and high prices in, for example, the Tech boom of the 1990s, together with the elevated levels of systematic and idiosyncratic variability in, for instance, the

2008 financial crisis (see also Figure 2). We address the cyclicality of idiosyncratic return variances in Section 6.

Consider the price earnings ratio for a portfolio with unit exposure to *ADR* and *AEG* and no idiosyncratic cash flow shocks. This portfolio consequently contains only systematic risk and can be viewed as a benchmark global "market" portfolio. Because of the non-linearities in the model, this portfolio's return and all its moments are a function of all state variables. We can then approximate the gross return for this portfolio as a linear function of the state variables. Conditional on this linearization, the conditional variance of this market portfolio is a function of any state variable that has a time-varying conditional variance. In this model, aggregate cash flow and discount rate uncertainty are therefore the only variables that matter. Exploiting this fact, we use the conditional market variance together with the conditional variance of cash flows as empirical proxies spanning these two types of uncertainty in the model. For an individual firm, the variability of firm-specific earnings growth is an additional variable driving its return variability, conditional on a similar linearization.

If we control for all systematic sources of return variability perfectly, the time variation in the conditional idiosyncratic return variability would primarily be a function of idiosyncratic cash flow variability. However, standard models to compute idiosyncratic variability, such as our Fama-French model, are unlikely to adjust for all systematic sources of returns, consistent with the model. Moreover, absent the linearization, computing the conditional variance of returns involves taking the conditional variance of an infinite sum of exponentials of a linear function of the state variables;

thus, all state variables should matter.[5] This implies that the total volatility and idiosyncratic volatility for every firm depend on all the state variables introduced here.

The pricing model thus suggests that the following variables span the aggregate idiosyncratic return variance: the aggregate discount rate, the conditional market variance, aggregate growth opportunities, the aggregate return on equity, the conditional variance of aggregate cash flows, and, importantly, the aggregate idiosyncratic cash flow variance. Our empirical approach then links the aggregate idiosyncratic return variance to the empirical proxies for these variables in a regression framework.

5. Explaining the Global Commonality in Idiosyncratic Return Variances

In this section, we describe the construction of each state variable in Section 4 and use them to explain the global commonality in idiosyncratic return variances. Section 5.1 focuses on the aggregate idiosyncratic cash flow variance, since it is potentially the most fundamental source of comovement across idiosyncratic return variances. Section 5.2 describes the construction of the other state variables. Finally, Section 5.3 reports the explanatory power of the various state variables.

5.1 Aggregate Idiosyncratic Cash Flow Variance

Idiosyncratic cash flow variability is a natural determinant of idiosyncratic return variability. While there has been some research linking the time variation of U.S. aggregate idiosyncratic return variances to cash flow variances (see Wei and Zhang (2006), Bekaert, Hodrick,

[5] Veronesi (1999) and Pastor and Veronesi (2006) suggest that in a learning story, the dependence of endogenous variables on state variables may be different in good times and bad times. Such a channel to generate business cycle dependence is missing in our model.

and Zhang (2012), Herskovic et al. (2016), and Bartram, Brown, and Stulz (2017)), there has been virtually no research on this link in an international context.[6] In this section, we first propose a method to calculate the idiosyncratic cash flow variance. Then, we examine the commonality in idiosyncratic cash flow variances, following a parallel structure to Section 3, in which we document strong commonalities of idiosyncratic return variances across countries.

5.1.1 Defining Idiosyncratic Variances of Cash Flows

There is no well-accepted methodology to compute idiosyncratic variances of cash flow variables. Irvine and Pontiff (2009) use a pooled AR(3) model for firms' earnings per share to create earnings innovations, and then use the cross-sectional variance of these innovations as a fundamental idiosyncratic risk variable. Zhang (2010) and Bekaert, Hodrick, and Zhang (2012) use the value-weighted firm-level time series variance of return on equity computed using the last 12 quarters of data, and the cross-sectional variance of return on equity. Bartram, Brown, and Stulz (2017) use the squares of the change in various measures of cash flows for firm i minus the value weighted cash flow change across all firms. These approaches either fail to control for systematic exposure or make other strong implicit assumptions, such as unit betas with respect to simple aggregate benchmarks.

We propose a new methodology using ROE as our cash flow variable as in Vuolteenaho (2002). The ROE is defined as earnings divided by last period's book equity. For the U.S. sample, we obtain quarterly "Net Income" (NIQ) and the "Book Value of Common Equity" (CEQQ) from the Compustat quarterly file. To mitigate potential seasonality in our quarterly ROE data, we compute an annualized ROE as the trailing 4-quarter net income divided by common equity at the beginning of the period. Thus, for firm i at quarter q, annualized ROE is computed as follows:

[6] Bekaert, Hodrick, and Zhang (2012)'s last section provides some preliminary analysis for the G7 countries.

$$ROE_{iq} = \frac{\sum_{t=q-3}^{q} Net\ Income_{i,t}}{Common\ Equity_{i,q-4}}. \quad (15)$$

For firms outside of the U.S., we compute ROE by dividing "Net Income" (WC01651 or DWNP) by the "Book Value of Common Equity" (WC03501 or DWSE). Notice that the coverage of non-U.S. firms' accounting data can be sporadic at the beginning of the sample, with only annual data of the accounting variables being available. Nevertheless, because our data only covers 38 years, we choose to use the quarterly frequency for our ROE time series data. When the quarterly data are available, we compute ROE for non-U.S. firms as in equation (15). When only annual data are available, we transform the annual data to quarterly data by computing ROE for firm *i* at quarter *q* in year *y* as follows:

$$ROE_{iq} = \frac{\frac{q}{4} Net\ Income_{i,y} + (1-\frac{q}{4}) Net\ Income_{i,y-1}}{Common\ Equity_{i,y-1}}. \quad (16)$$

That is, we approximate quarterly observations of net income, using annual net income, as a weighted average of the annual net income from the previous year, *y-1*, and the current year *y*.[7]

To compute idiosyncratic cash flow shocks, we construct a linear factor model that mimics the approach in Bekaert, Hodrick, and Zhang (2009) to explain comovements of international stock returns. The model combines local and global Fama and French (1993) factors, that is, factors capturing the market, size, and value dimensions, for firm-level ROE's. Similar to the construction of return factors in Section 2.2, we construct the country ROE market factor as the value-weighted ROE of all firms in the country. The size ROE factor is the difference between value-weighted ROEs of the smallest 1/3 of firms and largest 1/3 of firms. The value ROE factor is the difference

[7] For robustness, we also compute all ROE measures using only annual data. In addition, we consider an alternative transformation by computing quarterly observations of annual ROE as weighted average of the annual ROE from the current and previous years: $ROE_{i,q}$= q/4*$ROE_{i,y}$+(4-q)/4*$ROE_{i,y-1}$. The results are generally similar to what we report in the main text and are available upon request.

between the value-weighted ROEs of the 1/3 of firms with the highest B/Ms and the 1/3 of firms with the lowest B/Ms. Global ROE factors are value-weighted country-level ROE factors.[8]

We use these ROE factors to estimate a factor model for firm-specific ROE's using both the country and global factors. Given the low frequency nature of the accounting data, we estimate the following panel model within each country:

$$ROE_{iq} = \left(a_{0,i} + a_1 size_{i,q-1} + a_2 BM_{i,q-1}\right) + \left(b_0 + b_1 size_{i,q-1} + b_2 BM_{i,q-1}\right) WMKT_q^{ROE}$$
$$+\left(c_0 + c_1 size_{i,q-1} + c_2 BM_{i,q-1}\right) WSMB_q^{ROE} + \left(d_0 + d_1 size_{i,q-1} + d_2 BM_{i,q-1}\right) WHML_q^{ROE}$$
$$+\left(e_0 + e_1 size_{i,q-1} + e_2 BM_{i,q-1}\right) MKT_{C,q}^{ROE} + \left(f_0 + f_1 size_{i,q-1} + f_2 BM_{i,q-1}\right) SMB_{C,q}^{ROE}$$
$$+\left(g_0 + g_1 size_{i,q-1} + g_2 BM_{i,q-1}\right) HML_{C,q}^{ROE} + u_{iq}^{ROE}, \quad (17)$$

where $size_{i,q-1}$ and $BM_{i,q-1}$ are the log size and the book-to-market ratio for firm *i* from the previous quarter *q-1*, and each country ROE factor is orthogonalized with respect to the global counterpart. We allow for time and cross firm variation in the factor loadings, with the factor loadings being linear functions of firm's own size and book-to-market ratio. With only quarterly observations on ROE, the panel specification substantially increases statistical power. We also include firm fixed effects to take into account constant firm-level differences in ROE. This new methodology to compute idiosyncratic variances of cash flow variables does not make the strong assumptions implicit in the existing methodologies. [9]

[8] The summary statistics for the country and global ROE factors can be found in the Online Appendix Table OA1, Panel A. The ROE market factors are on average positive for all countries, ranging between 7.57% (Japan) and 18.97% (U.S.). Interestingly, the country size factors are all negative on average, ranging between -20.11% (U.S.) and -4.40% (Austria), indicating small firms have lower ROE's than large firms. The value factors are also all negative ranging between -23.28% (U.K.) and -6.21% (Japan). On average, value firms have lower ROEs than growth firms.
[9] We report the parameter estimates for the panel regression in the Online Appendix Table OA1, Panel B.

The key deliverable of the model is the idiosyncratic cash flow residual, u_{it}^{ROE}. Because we only observe one residual for each firm in each quarter, we employ a kernel method to estimate the idiosyncratic ROE variance over 20 quarters, as follows:

$$IVROE_{iq} = \sum_{k=-10}^{10} w_k (u_{iq}^{ROE})^2, \tag{18}$$

where the kernel is Gaussian with a bandwidth of 4 quarters:

$$w_k = \frac{w_k^*}{\sum_{k=-10}^{10} w_k^*}, \text{ and } w_k^* = \frac{1}{4\times\sqrt{2\pi}} e^{-\frac{\left(\frac{k}{4}\right)^2}{2}}. \tag{19}$$

That is, the kernel estimate for quarter q puts the most weight on quarter q's squared residual (the weight is 0.101), but it also uses "nearby" squared residuals up to 10 quarters before and after the current quarter, with the lowest weight being 0.004. Lacking higher frequency data, the kernel method exploits slower moving ROE dynamics and the persistence of variances, to provide an adequate variance estimate, centered around the current squared residual.[10] To mitigate the effect of outliers, we delete the top 1% observations in each country.

Summary statistics for IVROE are reported in Panel A of Table 4, Columns I and II. For each country, we report the time-series averages of the cross-sectional medians of firm-specific IVROE in Column I. The median IVROE is the highest for Norway at 0.019 and lowest for Japan at 0.002. For the U.S., the median IVROE is 0.007. As shown in Column II, the average country IVROE ranges between 0.005 (Singapore) and 0.025 (Israel), and the U.S. IVROE is 0.018 on average, putting it approximately at the 75th percentile of all countries. Figure 2, Panel A presents time series of country IVROEs for Germany, Japan, the U.K., and the U.S., respectively. Both the U.K. and the U.S. feature elevated IVROEs around 2001, 2008, and 2017, while the IVROE of

[10] Alternatively, we can define a spot measure of IVROE for each quarter q as the squared residual, $(u_{iq}^{ROE})^2$. Our results are qualitatively similar using this measure. We employ the kernel measure because it is a more adequate estimate for variance and better captures the slow-moving dynamics of ROEs.

Germany is highest in 2003, which is about the mid-point of Germany's recession then. The IVROE of Japan exhibits significantly less time variation compared to the IVROE of other countries.

Finally, we compute the global IVROE, $IVROE_q^G$, as the value-weighted average of country level IVROE in quarter q. The global IVROE has a mean of 0.013 and a standard deviation of 0.004. The time-series plot for global IVROE is presented in Figure 2, Panel B. The global IVROE peaks around 2000 and in the global financial crisis in 2008, similar to the global IVRET measure, except that the global IVROE also shows a recent peak in 2017.

We also consider seven alternative models to estimate IVROE. First, we estimate the panel model using three versions of a 20-quarter estimation: rolling windows, either using the last squared residual of the rolling window or the actual variance of the 20-quarter period, and seven non-overlapping samples of 20 quarters, where we use the squared residuals. Second, we also consider an alternative more parsimonious model, which we estimate for each firm i in each country C (we require at least 15 observations):

$$ROE_{iq} = a_i + b_i WMKT_q^{ROE} + c_i MKT_{C,q}^{ROE} + u_{iq}^{ROE} \tag{20}$$

This model is estimated using the four approaches used for the panel model (full sample, two rolling windows approaches, non-overlapping 20 quarter samples).

For all these models, we verify that the residuals do not feature substantive common components by tabulating properties of the cross-country residual correlations (see Online Appendix Table OA2). The rolling window methodologies, whatever model is used, deliver mostly uncorrelated residuals (the average correlation is below 0.1), whereas the full sample methodologies leave more positive correlations, which can be on average close to 0.2. While we show the results for the full sample panel model, we derive all ensuing results for all eight models and they prove remarkably robust. We therefore retain the full sample panel model.

5.1.2 Commonality in Country and Firm Idiosyncratic ROE Variances

The evidence presented in Section 3.1 and 3.2 indicates that country and firm idiosyncratic return variances share important commonalities, and the global IVRET captures this commonality to a large extent. Do country and firm idiosyncratic ROE variances show the same pattern? To examine this question, we first report the average pairwise correlation coefficients for each country's IVROE in Panel A of Table 4, Column III. The cross-country average of pairwise correlations of country IVROEs is 0.138, and the average pairwise correlation between the U.S. and other country's IVROE is 0.115. In comparison with the correlations of IVRET, while the correlations of IVROE are positive overall, they are substantially lower than those associated with idiosyncratic return variances. Our panel full sample methodology to estimate IVROE delivers a very conservative estimate of the comovement, as the alternative methodologies all deliver higher average correlations, varying between 0.169 and 0.235.

Can the commonality in IVROE be captured by the global IVROE? To answer this question, we estimate the following time-series regression by country:

$$IVROE_q^C = \alpha_C^{ROE} + \beta_C^{ROE} IVROE_q^G + \varepsilon_q^{C,ROE} \ . \tag{21}$$

The loadings on the global IVROE, β_C^{ROE}, reported in Column IV of Table 4, are positive in 18 out of 23 countries, and are statistically significant in most cases. The R^2 in Column VI is on average 0.203, varying between 0.461 and 0.796 for the largest countries (U.S., U.K., and Japan). Column VII further presents the pairwise correlations of the residuals $\varepsilon_q^{C,ROE}$, which are on average 0.057, much lower compared to the pairwise correlations of country IVROE of 0.138. That is, the global IVROE variance is clearly important for explaining country level IVROE. In comparison with the results in Table 2, the explanatory power of global IVROE for country IVROE is weaker than that of global IVRET for country IVRET.

In addition to the regression approach, we also adopt a principal component analysis approach and show an alternative perspective for commonality of country IVROEs. In Table 4, Panel B, the first PC of country IVROE explains 62.5% of the cross-sectional variation in country IVROEs, and the second PC explains around 17%. The global IVROE is 0.608 correlated with the first and 0.530 correlated with the second PC.

Section 3.2 provides evidence for firm-level commonality in IVRETs both within country and across countries. Can this commonality be attributable to the commonality in firm-level IVROEs? In Table 4, Panel C, we first report summary statistics regarding the commonality in firm-level IVROEs within each country. of the results.[11] In Column I, we present the time-series average of the percentage of overall variance explained by the first PC within each country over the three subperiods. On average, the first PC explains 54.8% of the variation in firm IVROEs. For firms in each country, we estimate the regression of firm IVROE on country IVROE and report the median adjusted R^2 from the regression in Column II. The average median adjusted R^2 across countries is 0.141. We then additionally include global IVROE in the regression and show the median adjusted R^2 in Column III. The addition of global idiosyncratic variance increases the adjusted R^2 to 0.376 on average, which more than doubles the explanatory power for firm IVROE. These results indicate that the global IVROE captures a large part of commonality in firm-level IVROEs. Panel D of Table 4 further examines the commonality in firm IVROEs across countries, using PC analysis. The first (second) PC explains 38.3% (28.4%) of the variation in firm IVROEs in all countries. With relatively high variations explained by both first and second PCs, both PCs

[11] The country-by-country results are reported in the Online Appendix Table OA3.

are important for describing the commonality of firm IVROEs. The global IVROE is strongly correlated with the first PC with a correlation of 0.410, and even more strongly correlated with the second PC, with a correlation of 0.725.

The evidence altogether suggests that similar to idiosyncratic return variances, idiosyncratic cash flow variances also exhibit a surprisingly important global component.

5.2 Other State Variables

In this subsection, we briefly outline the measurement of the other state variables at the quarterly frequency. All the data are obtained from Datastream. Further details can be found in the Appendix.

We begin with the conditional variance of global market returns, *ACV*. In the model, this variance is spanned by discount rate and cash flow uncertainty so that we can equivalently employ this aggregate market return uncertainty and cash flow uncertainty as the two state variables. That is, *ADRV* is replaced by *ACV*. Bekaert, Hodrick, and Zhang (2012) find an estimate of aggregate return uncertainty to be significantly linked to aggregate idiosyncratic uncertainty in the U.S., a result recently confirmed by Bartram, Brown, and Stulz (2017). Inspired by Corsi (2009) and Bekaert and Hoerova (2014), we estimate *ACV* as the fitted value of the regression below:

$$RV_q^q = a + bVIX_{q-1}^2 + cRV_{q-1}^q + dRV_{q-1}^m + eRV_{q-1}^w + v_q, \tag{22}$$

where the quarterly realized variance of daily global market returns in quarter q, RV_q^q, is projected on the squared VIX index, and the quarterly, monthly, and weekly realized variances of daily returns at the end of the previous quarter.

The second state variable is the global discount rate *ADR*, which is the conditional expected global market gross return. Therefore, we compute *ADR* as the fitted value from the following regression specification:

$$\ln(1 + RET_q) = a + bACV_{q-4} + cADY_{q-4} + d\left(VIX_{q-4}^2 - ACV_{q-4}\right) + u_q, \qquad (23)$$

where RET_q is the return on the Datastream World Market Index over quarters (q-3, q), ACV is the conditional market variance, ADY is the global dividend yield. The last independent variable is the variance premium measured by the difference between the squared VIX index and the conditional market variance, which was first shown to predict equity returns in Bollerslev, Tauchen, and Zhou (2009). Under the null of the CAPM, the aggregate conditional variance should capture time variation in risk premiums, but the variable has proven to be a weak predictor of future stock returns. By including the highly persistent dividend yield, likely the most popular predictor of stock returns, and the much less persistent variance risk premium, the specification potentially embeds both a persistent and more rapidly mean-reverting component in expected stock returns (see also Martin (2017) and Bekaert and Hoerova (2014)).

The three remaining state variables characterize cash flow growth dynamics. Given our focus on ROE as the cash flow concept, we focus on global ROE, which is computed as net income (NI) divided by lagged book value (BV) of the Datastream World Market Index. Then we compute $AROE$ as the natural logarithm of (1+ global ROE).

Our fourth state variable is the conditional aggregate variance of the cash flows, AEV. To obtain the time series of this conditional variance, we estimate the following GARCH-in-Mean specification:

$$AROE_q = a + bAROE_{q-4} + cAEY_{q-4} + dACV_{q-4} + eADR_{q-4} + fV_{q-4} + u_q, \qquad (24)$$

$$V_{q-4} = E_{q-4}\left[u_q^2\right] = \exp\left(\alpha + \beta ln(u_{q-4}^2) + \gamma AEY_{q-4} + \rho ACV_{q-4} + \varphi ADR_{q-4}\right), \qquad (25)$$

with AEY_q representing the global earnings yield. The parameters are estimated by maximum likelihood and are presented in the Appendix. The fitted value of V_q is the conditional variance of cash flows, AEV.

In the model, the cash flow equation for earnings growth and ROE features the last, unobserved state variable, *AGO*. However, under the null of the model, the earnings yield is an exact function of all the state variables, including *AROE, ADR*, and the conditional variance variables. The growth opportunity variable should represent the part of the earnings yield that is unrelated to discount rates, cash flows and their variances, and by definition increase expected earnings growth and also the variability of the firm's future cash flows. Using the model's implication for the earnings yield, we then obtain *AGO* as the residual from the following regression:

$$AEY_q = a + bAROE_q + cACV_q + dADR_q + eAEV_q - AGO_q. \tag{26}$$

For AGO to be a valid growth opportunity variable, it should predict earnings growth. In each quarter, we calculate EBIT growth for the Datastream Total Market Index as the growth rate of trailing 4-quarter EBIT over the same quarter of the previous year. A projection of this annual earnings growth rate at t+k on AGO_t yields statistically significant coefficients on AGO_t (at the 10% level or better) for k = 4 through 6. The predictive power is strongest for earnings growth one year ahead (k = 4) with a coefficient (t-statistic) of 7.655 (2.85) and an adjusted R^2 of 0.178. We report the regression results in Online Appendix Table OA4, Panel A.

5.3 Explaining the Global Component in Idiosyncratic Return Variances

Table 5, Panel A reports the summary statistics and correlations for the global IVRET and all the state variables. In terms of mean and standard deviation, the discount rate is on average 7.93%, with a 5.98% volatility. The latter is quite high, consistent with recent work by Martin (2017) and Bekaert, Engstrom, and Xu (2019). In comparison, the AROE has a higher mean at 11.34%, and a lower volatility of 2.13%, which is consistent with the smooth nature of cash flow variables. Note that the mean of the growth opportunity variable is zero (as it represents a residual from a regression).

We first link the state variables to global IVRET by presenting correlations. The correlation between global IVRET and global IVROE is 0.451, suggesting that global IVROE can indeed explain a substantial part of the variation in global IVRET, consistent with our pricing model. Additionally, global IVRET is significantly correlated (at the 10% level) with all the other state variables except AEV. The correlation between global IVRET and the discount rate is negative, which is surprising because it is typically surmised that discount rates are countercyclical (see e.g. Campbell and Cochrane, 1999). We verified that the negative correlation with idiosyncratic variables is mostly driven by the extreme low discount rate period occurring during the Tech Boom, which coincided with very elevated idiosyncratic variances.

To further investigate what explains the global component of the idiosyncratic return variances, we first project it on each of the six state variables suggested by the model one by one, then we include all the state variables together in the final regression. From Table 5, Panel B, five out of the six state variables have significant coefficients (at the 10% level) in univariate regressions I to VI, which is consistent with the correlation results above. Global IVROE has a positive and highly significant coefficient, and by itself produces an adjusted R^2 of 0.265. High discount rates are associated with low IVRET. The coefficient is -0.286 with a t-statistic of -5.57, and the adjusted R^2 is 0.203. Meanwhile, better growth opportunities are also associated with high IVRET, with a coefficient of 0.762 (t=1.95), and an adjusted R^2 of 0.023. This result is consistent with the finding in Cao, Simin, and Zhao (2008) and Bekaert, Hodrick, and Zhang (2012) that the market to book ratio is significantly correlated with the aggregate idiosyncratic return variance, which they interpret as a growth opportunity effect. Our result is stronger in that we use a price variable cleansed of discount rate effects and shown to predict future earnings growth.[12]

In regression VII, when all the state variables are included, the adjusted R^2 is 0.595, and all state variables are statistically significant except AEV. We report a covariance decomposition for regression VII in the last column. That is, for each state variable $X_{t,i}$, we report the estimate of $cov(\widehat{y_t}, \widehat{\beta_i} X_{t,i})/var(\widehat{y_t})$, where $\widehat{y_t}$ is the fitted value of the regression and $\widehat{\beta_i}$ is the regression coefficient for state variable *i*. This decomposition adds to 100% across the different explanatory variables. Three state variables contribute meaningfully to variation in idiosyncratic variances, global IVROE (accounting for 33.97% of the explained variation), the conditional market variance (accounting for 23.74%), and the discount rate (accounting for 31.25%). Our results are robust to our seven alternative methods to estimate IVROE. The coefficient on global IVROE is always significant, and the variation explained by global IVROE based on the covariance decomposition is 30.7% when averaged across the seven alternative methods.

While the R^2 is high, it does not fully reflect the explanatory power of these state variables. Because of the non-linearity in the pricing model, higher order functions of the state variables are likely to matter as well. When we partially accommodate these non-linearities, by running a regression of IVRET on the levels, squares and cross-products of the state variables, the adjusted R^2 increases to 0.834.[13] Hence, our state variables almost perfectly fit the time-series variation in global idiosyncratic variances.

[12] To verify the robustness of our results to an alternative growth opportunity variable, we recalculate our results using the market to book ratio for the Datastream World Market Index, and report the results in Online Appendix Table OA4, Panel B and Panel C. We find the M/B ratio to be a significant determinant of the global IVRET variable, but it fails to predict future earnings growth, so that it is not clear it really captures growth opportunities.

[13] The regression results are reported in the Online Appendix Table OA5.

Overall, our results suggest that the time-series variation of the global idiosyncratic return variance is most substantially related to the global idiosyncratic cash flow variance, the conditional market variance and aggregate discount rate variation.

6. Cyclicality of Idiosyncratic Variances

The models of Cao, Simin and Zhao (2008) and Pastor and Veronesi (2003, 2006) suggest that the idiosyncratic variances are procyclical, meaning they are high in good economic times, but low during recessions. The macro literature, on the other hand, proposes that high uncertainty predicts future economic slowdowns.[14] Additionally, the time-series plots of idiosyncratic variances in Figures 1 and 2 seem to suggest that they tend to increase in recessions. In this section, we formally examine the cyclicality of idiosyncratic variances in our global sample.

To measure business cycles, we focus on NBER business cycle dates and GDP growth. NBER expansion is a dummy variable that is one during an NBER-dated expansion and zero during an NBER-dated recession. For global GDP growth, we obtain seasonally adjusted nominal GDP and GDP deflator data aggregated over all OECD countries from the OECD. We first compute real GDP by deflating nominal GDP by the GDP deflator. Next, we calculate the annualized growth rate of real GDP in quarter q as follows:

$$\Delta GDP_q^G = \frac{\sum_{k=0}^{3} GDP_{q-k}^G}{\sum_{k=4}^{7} GDP_{q-k}^G} - 1. \tag{27}$$

To establish cyclicality, we compute the correlations between our global IVRET and IVROE measures and both business cycle indicators, at different leads and lags up to one year. Positive correlations indicate cyclicality, and negative correlations indicate counter-cyclicality. In

[14] Kozeniauskas, Orlik, and Veldkamp (2018) examine the relation between various types of uncertainty, including uncertainty based on firm-specific data. Aggregate idiosyncratic variances are a good proxy for this micro uncertainty.

addition, we also connect global IVRET and IVROE to future and current GDP growth, following Campbell, Lettau, Malkiel, and Xu (2001):

$$\Delta GDP_{q+4}^{G} = \alpha_1^{GDP} + \beta_1^{GDP,IVRET} IVRET_q^G + \beta_1^{GDP,\Delta GDP} \Delta GDP_q^G + \beta_1^{GDP,MKT} MKT_q^G + e_{1,q+4}, \quad (28)$$

$$\Delta GDP_q^G = \alpha_2^{GDP} + \beta_2^{GDP,IVRET} IVRET_q^G + \beta_2^{GDP,\Delta GDP} \Delta GDP_{q-4}^G + \beta_2^{GDP,MKT} MKT_{q-4}^G + e_{2q}. \quad (29)$$

where MKT_q^G is the global market return using the Datastream Total Market Index. A positive $\beta^{GDP,IVRET}$ implies that global IVRET is procyclical with respect to the global business cycle; a negative coefficient suggests counter-cyclicality. The second specification examines the contemporaneous relationship; the first specification verifies whether IVRET predicts further GDP growth. Similar specifications are applied to global IVROE.

6.1 Cyclicality of IVRET

We first report the correlation between global IVRET and NBER expansion at leads and lags up to a year in the first column of Table 6, Panel A. We find that all correlations between global IVRET and NBER expansion are negative, mostly statistically significant, implying that global IVRET exhibits counter-cyclicality with respect to the U.S. cycle. When we use GDP growth as business cycle indicator, the pattern is slightly different from that using NBER dates. The correlations monotonically decrease from the top to the bottom: global IVRET is positively correlated with lag 4-quarter GDP growth, with a coefficient of 0.254; then it gradually decreases to 0.128 at lag 1; the contemporaneous relation is 0.048 (statistically insignificant); the correlation slowly turns negative to -0.050 for one-quarter ahead GDP growth; eventually, the correlation becomes significantly negative at -0.237 for 4-quarter ahead GDP growth. The negative correlations with future GDP growth confirm several recent macro papers, such as Bloom (2009) and Jurado, Ludvigson, and Ng (2015), which have suggested that "uncertainty" is negatively linked to future economic activity. But we also observe positive correlations for lagged GDP growth, inconsistent with counter-cyclical behavior for IVRET.

We report the regression results in Panel B of Table 6. In the first regression, we find that when used to predict future GDP growth, global IVRET has a coefficient of -0.061, with an insignificant t-stat of -1.18. In regression II, when used to explain contemporaneous GDP growth, global IVRET has a coefficient of -0.023 with a t-stat of -0.41. Thus, while the negative coefficients indicate counter-cyclicality, we find no statistical evidence in favor of counter-cyclicality of IVRET at the global level.

6.2 Cyclicality of IVROE

In the remaining columns in Table 6, Panel A, we report analogous results for global IVROE. All correlation coefficients are negative for both business cycle indicators, indicating strong counter-cyclicality. We observe stronger counter-cyclicality for global IVROE than for IVRET, especially when we use the GDP growth measure.

We also estimate equations (28) and (29) for IVROE, and the estimation results are reported in Panel B of Table 6. Recall that a negative coefficient indicates counter-cyclicality and vice versa. In regression III (IV), the coefficient of IVROE is -0.462 (-0.415) with a t-statistic of -2.10 (-1.72), indicating strong counter-cyclicality. The strong counter-cyclicality of IVROE is interesting, because IVROE matches well with uncertainty concepts in the macroeconomic literature. For example, the "risk shock" in Christiano, Motto, and Rostagno (2014) measures uncertainty about the productivity of a firm's capital investment, which is more closely related with the IVROE concept than, with say, return variances or aggregate GDP uncertainty. We are not aware of anyone in the macroeconomic literature measuring uncertainty shocks using a cash flow concept such as ROE.

While for global idiosyncratic variances, countercyclicality is only statistically present for cash flows, but not for returns, the country-by-country evidence is more uniform. In Table 6, Panel C, we report the summary statistics of correlations between country IVRET (IVROE) and country GDP growth.[15] We observe a clear pattern of counter-cyclicality with respect to future GDP growth: for example, out of the 23 countries, 22 (18) show negative correlations between IVRET (IVROE) and lead 4-quarter GDP growth, and 17 (13) of these correlation coefficients are statistically significant. In the case of the U.S. (reported in the Online Appendix Table OA6), IVRET is negatively correlated with future GDP growth up to one year, and the correlations are especially significant when using lead 3-quarter or 4-quarter GDP growth. For U.S. IVROE, all lead and lag correlations with GDP growth up to a year are negative, and the correlations with contemporaneous and future GDP growth are all statistically significant.

Is the counter-cyclicality result for IVRET and IVROE consistent with previous model predictions? In Herskovic et al. (2016), the time-series variation in idiosyncratic return variances in the U.S. is shown to be relatively highly correlated to the dispersion of individual income growth and the cross-sectional dispersion of sectoral employment growth. This motivates an incomplete market's model in which idiosyncratic cash flow risk is directly linked to the dispersion in individual consumption growth. Our evidence confirms that both cash flow and return idiosyncratic variances are countercyclical, which is also the case for the income variables explored by Herskovic et al. (2016). Unfortunately, it seems somewhat difficult to reconcile the international evidence we uncover with their model. For this to work, an international component of the idiosyncratic uninsurable consumption risk of households must be a main driver of the global component in idiosyncratic return and cash flow variances, while one of the most enduring puzzles

[15] The country-by-country results are reported in the Online Appendix Table OA6.

in international economics is that the correlation of consumption growth across countries is quite low and difficult to explain (see e.g. Backus and Smith (1993)).

6.3 Robustness Checks

In our analysis above, we use NBER recession dates and GDP growth rates to measure cyclicality. As robustness checks, we compute cyclicality using two alternative cyclicality measures. Our first alternative measure is the output gap, computed as the difference between the quarterly GDP level and a quadratic trend, estimated over the full sample. Our second alternative measure uses Hodrick-Prescott (1997) filtered GDP levels (HPGDP henceforth), where the smoothing parameter is set to 1600. These measures are positively correlated with GDP growth rates, but with correlations below 0.50. From Panel D of Table 6, the results with alternative cycle measures are mostly consistent with those in Panel A and B, in the sense that IVRET and IVROE are mostly counter-cyclical, but statistical significance is lacking.

One possible explanation for the lack of statistical significance over the full sample is that the cyclicality of IVROE and IVRET varies over time. After all, Cao, Simin, and Zhao (2008) and Pastor and Veronesi (2006) suggest that IVRET may be procyclical. To better understand whether this is the case, we compute rolling-window correlations between global idiosyncratic variances and GDP growth rates. That is, in each quarter q, we calculate the correlation over the quarters (q-19, q) between the global idiosyncratic variance with global GDP growth at quarter q. We plot the rolling correlations for IVROE and IVRET in Figure 3, Panels A and B, respectively. For IVRET, more than 60% of the correlations are negative, but they become positive around the internet bubble period between 1995 and 2005, and turn slightly positive again after 2015. For IVROE, more than 59% of the correlations are negative, except for a short period between 1997 and 2005, and after 2015.

Overall, we conclude that countercyclicality is a dominant feature of the data when using GDP growth rates to measure cyclicality, but there are time periods during which IVRET and IVROE are procyclical.

7. Conclusion

This article first shows that aggregate idiosyncratic return variances at the country level are highly correlated, often as highly correlated as are actual returns. The global idiosyncratic return variance explains a substantial fraction of country level idiosyncratic return variances. We then find a large common component in firm-specific idiosyncratic return variances, with the global idiosyncratic variance adding substantive explanatory power beyond the country-specific idiosyncratic return variance.

To embark on an initial understanding of the empirical dynamics of idiosyncratic variances, we develop a pricing model with stochastic discount rates, stochastic expected earnings growth and growth options, and time-varying cash flow variability. In the model, volatility dynamics are affected by the following key state variables: the aggregate discount rate, the aggregate conditional market variance (which we decompose into aggregate cash flow variability and pure discount rate variability), expected cash flow growth, idiosyncratic earnings variance, and a growth opportunity variable that we extract from the aggregate earnings yield. Importantly, this latter variable is shown to predict earnings growth and thus its positive link with idiosyncratic return variances is consistent with the mechanism described in Cao, Simin, and Zhao (2008). While we could in principle price each firm in the world, we use the model to shed light on the global component in idiosyncratic return variances linking its time series variation to the global idiosyncratic cash flow variance and other global state variables.

The most important state variable to explain the variation in global idiosyncratic return variances is the global idiosyncratic cash flow variance, where the idiosyncratic cash flow variance is calculated in a novel way using the residuals from a factor model with time-varying factor loadings. The idiosyncratic cash flow variance exhibits similar but somewhat weaker international commonality as does the idiosyncratic return variance. In addition to the global idiosyncratic cash flow variance, the global discount rate and the conditional market variance help explain a substantial fraction of the variation in idiosyncratic return variances. If we include all state variables together, with only linear terms, the model explains more than 59% of the variation in idiosyncratic return variances.

Our results may prove useful input for a rapidly growing macroeconomics literature linking economic and financial uncertainty (shocks) to economic activity (see Bloom (2009); Christiano, Motto, and Rostagno (2014); and Jurado, Ludvigson, and Ng (2015)). While most of the literature resorts to aggregate return uncertainty variables, the economic concepts are more appropriately linked to cash flow uncertainty or ROE uncertainty. ROE volatility may also be a proxy for the volatility of investment shocks, which Justiniano and Primiceri (2008) argue played an important role in the Great Moderation and reflect shocks to the return on capital or the marginal efficiency of the investment technology in a DSGE model. Our work shows that the global idiosyncratic ROE variance is strongly counter-cyclical.

References

Ang, Andrew, and Jun Liu, 2004, How to discount cashflows with time-varying expected returns, *Journal of Finance* 59, 2745-2783.

Backus, David K., and Gregor W. Smith, 1993, Consumption and real exchange rates in dynamic economies with non-traded goods, *Journal of International Economics* 35, 297-316.

Bakshi, Gurdip, and Zhiwu Chen, 2005, Stock valuation in dynamic economies, *Journal of Financial Markets* 8, 111-151.

Bartram, Söhnke M., Gregory Brown, and René M. Stulz, 2012, Why are U.S. stocks more volatile?, *Journal of Finance* 67, 1329–1370.

Bartram, Söhnke M., Gregory Brown, and René M. Stulz, 2017, Why does idiosyncratic risk increase with market risk?, *Working Paper*.

Bekaert, Geert, Eric Engstrom, and Nancy Xu, 2021, The time variation in risk appetite and uncertainty, *Management Science*, forthcoming.

Bekaert, Geert, and Campbell R. Harvey, 2000, Foreign speculators and emerging equity markets, *Journal of Finance* 55, 565-613.

Bekaert, Geert, Robert J. Hodrick, and Xiaoyan Zhang, 2009, International stock return comovements, *Journal of Finance* 64, 2591–2626.

Bekaert, Geert, Robert J. Hodrick, and Xiaoyan Zhang, 2012, Aggregate idiosyncratic volatility, *Journal of Financial and Quantitative Analysis* 47, 1155–1185.

Bekaert, Geert, and Marie Hoerova, 2014, The VIX, the variance premium and stock market volatility, *Journal of Econometrics* 183, 181-192.

Bloom, Nicholas, 2009, The impact of uncertainty shocks, *Econometrica* 77, 623-685.

Bollerslev, Tim, George Tauchen, and Hao Zhou, 2009, Expected stock returns and variance risk premia, *Review of Financial Studies* 22, 4463-4492.

Brown, Gregory, and Nishad Kapadia, 2007, Firm-specific risk and equity market development, *Journal of Financial Economics* 84, 358-388.

Campbell, John Y., and John H. Cochrane, 1999, By force of habit: A consumption-based explanation of aggregate stock market behavior, *Journal of Political Economy* 107, 205-251.

Campbell, John Y., Martin Lettau, Burton G. Malkiel, and Yexiao Xu, 2001, Have individual stocks become more volatile? An empirical exploration of idiosyncratic risk, *Journal of Finance* 56, 1–43.

Cao, Charles, Timothy Simin, and Jing Zhao, 2008, Can growth options explain the trend in idiosyncratic risk?, *Review of Financial Studies* 21, 2599–2633.

Christiano, Lawrence J., Roberto Motto, and Massimo Rostagno, 2014, Risk shocks, *American Economic Review* 104, 27-65.

Corsi, Fulvio, 2009, A simple long memory model of realized volatility, *Journal of Financial Econometrics* 7, 174–196.

Dew-Becker, Ian, and Stefano Giglio, 2021, Cross-sectional uncertainty and the business cycle: Evidence from 40 years of options data, *Working Paper*.

Duarte, Jefferson, Avraham Kamara, Stephan Siegel, and Celine Sun, 2014, The systematic risk of idiosyncratic volatility, *Working Paper*.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in the returns on stocks and bonds, *Journal of Financial Economics* 33, 3-56.

Fama, Eugene F., and Kenneth R. French, 1996, Multifactor explanations of asset pricing anomalies, *Journal of Finance* 51, 55–84.

Goyal, Amit, and Pedro Santa-Clara, 2003, Idiosyncratic risk matters!, *Journal of Finance* 58, 975-1007.

Guo, Hui, and Robert Savickas, 2008, Average idiosyncratic volatility in G7 countries, *Review of Financial Studies* 21, 1259–1296.

Herskovic, Bernard, Bryan Kelly, Hanno Lustig, and Stijn Van Nieuwerburgh, 2016, The common factor in idiosyncratic volatility: Quantitative asset pricing implications, *Journal of Financial Economics* 119, 249–283.

Ince, Ozgur S., and R. Burt Porter, 2006, Individual equity return data from Thomson Datastream: Handle with care!, *Journal of Financial Research* 29, 463-479.

Irvine, Paul J., and Jeffrey Pontiff, 2009, Idiosyncratic return volatility, cash flows, and product market competition, *Review of Financial Studies* 22, 1149–1177.

Jurado, Kyle, Sydney C. Ludvigson, and Serena Ng, 2015, Measuring uncertainty, *American Economic Review* 105, 1177-1216.

Justiniano, Alejandro, and Giorgio E. Primiceri, 2008, The time-varying volatility of macroeconomic fluctuations, *American Economic Review* 98, 604-41.

Kozeniauskas, Nicholas, Anna Orlik, and Laura Veldkamp, 2018, What are uncertainty shocks?, *Journal of Monetary Economics* 100, 1-15.

Martin, Ian, 2017, What is the expected return on the market?, *Quarterly Journal of Economics* 132, 367-433.

Nissim, Doron, and Amir Ziv, 2001, Dividend changes and future profitability, *Journal of Finance* 56, 2111-2133.

Pastor, Lubos, and Pietro Veronesi, 2003, Stock valuation and learning about profitability, *Journal of Finance* 58, 1749–1789.

Pastor, Lubos, and Pietro Veronesi, 2006, Was there a Nasdaq bubble in the late 1990s?, *Journal of Financial Economics* 81, 61-100.

Veronesi, Pietro, 1999, Stock market overreactions to bad news in good times: a rational expectations equilibrium model, *Review of Financial Studies* 12, 975–1007.

Vuolteenaho, Tuomo, 2002, What drives firm-level stock returns?, *Journal of Finance* 57, 233–264.

Wei, Steven X., and Chu Zhang, 2006, Why did individual stocks become more volatile?, *Journal of Business* 79, 259–292.

Zhang, Chu, 2010, A reexamination of the causes of time-varying stock return volatilities, *Journal of Financial and Quantitative Analysis* 45, 663-684.

Appendix

This appendix describes the setup of our model and the estimation results for the state variables.

1. Model Setup

The model is formulated at the "global" level, and consists of dynamic processes for discount rates and cash flows. The model is essentially a dynamic version of the Gordon growth model; there is no explicit pricing kernel.

The conditional mean of the aggregate discount rate (ADR) features an autoregressive term but also loads on aggregate cash flow uncertainty (AEV), both in the conditional mean and the conditional variance:

$$ADR_t = \mu_{ADR} + \rho_{ADR} ADR_{t-1} + \phi_{ADR,AEV} AEV_{t-1}$$

$$+\sigma_{ADR}\sqrt{ADRV_{t-1}}\varepsilon_{ADR,t} + \sigma_{ADR,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t}. \quad \text{(A.1)}$$

Discount rate specific uncertainty (ADRV) follows a simple autoregressive process:

$$ADRV_t = \mu_{ADRV} + \rho_{ADRV} ADRV_{t-1} + \sigma_{ADRV}\sqrt{ADRV_{t-1}}\varepsilon_{ADRV,t}. \quad \text{(A.2)}$$

The aggregate cash flow uncertainty follows a square root process. The conditional mean of *AEV* has an autoregressive component, and also depends on a growth opportunity state variable, *AGO*, as suggested by Cao, Simin, and Zhao (2008):

$$AEV_t = \mu_{AEV} + \rho_{AEV} AEV_{t-1} + \phi_{AGO} AGO_{t-1} + \sigma_{AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t} \quad \text{(A.3)}$$

The growth opportunity variable, *AGO*, is modeled simply as a first order autoregressive process:

$$AGO_t = \rho_{AGO} AGO_{t-1} + \sigma_{AGO}\varepsilon_{AGO,t}. \quad \text{(A.4)}$$

Aggregate earnings growth (AEG) is defined as follows:

$$AEG_t = ln\frac{EA_t}{EA_{t-1}} \quad \text{(A.5)}$$

where EA is total earnings.

We model the conditional mean of aggregate earnings growth as driven by *AGO* and the past return on equity, *AROE*:

$$AEG_t = \mu_{AEG} + \phi_{AEG,AROE} AROE_{t-1} + \phi_{AEG,AGO} AGO_{t-1}$$

$$+\sigma_{AEG}\,\varepsilon_{AEG,t} + \sigma_{AEG,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t} \quad \text{(A.6)}$$

where *AROE* follows:

$$AROE_t = \mu_{AROE} + \rho_{AROE}AROE_{t-1} + \phi_{AROE,ADR}ADR_{t-1} + \phi_{AROE,AGO}AGO_t$$
$$+\sigma_{AROE}\varepsilon_{AROE,t} + \sigma_{AROE,AEV}\sqrt{AEV_{t-1}}\varepsilon_{AEV,t} \qquad \text{(A.7)}$$

While the fundamental cash flow variable is at first glance earnings growth, the time variation in its conditional mean is spanned by *AROE* (to reflect the growth in earnings of assets in place) and the unobserved growth opportunity variable, *AGO*. The *AROE* process depends on the *AGO* variable as well, and then we let it also depend on both past roe and the discount rate. It is natural to expect firms with high ROE's relative to their costs of capital to grow and expand future earnings. However, ROE may also be expected to be mean reverting for a variety of reasons (abnormal values being caused by temporary factors; high ROEs should invite competition etc.), see Nissim and Ziv (2001) for some evidence. This could lead to negative $\phi_{AEG,AROE}$ coefficient. Importantly, the time variation in the volatility of both earnings growth and ROE is spanned by aggregate uncertainty, *AEV*, which is the sole variable representing aggregate cash flow variability.

This global pricing model is fully characterized by the state variable vector X_t = [ADR_t, $ADRV_t$, AGO_t , $AROE_t$, AEV_t]′. All shocks (ε's) are assumed N (0, 1).

In general, we assume that earnings are positive and are all paid out. Imagine the "global market" claim to all earnings; $EA_{t+j}, j = 0, 1, \dots, \infty$.

By definition of the discount rate:

$$P_t = E_t[\exp(-ADR_t)(P_{t+1} + EA_{t+1})] \qquad \text{(A.8)}$$

Or, to allow for a stationary representation,

$$PE_t = \frac{P_t}{EA_t} = E_t\{\exp(-ADR_t)[\exp(AEG_{t+1}) + \exp(AEG_{t+1})PE_{t+1}]\} \qquad \text{(A.9)}$$

So,

$$PE_t = E_t\{\sum_{j=1}^{\infty} \exp[\sum_{i=1}^{j}(-ADR_{t+i-1} + AEG_{t+i})]\} \qquad \text{(A.10)}$$

Thus, the PE solution is of the following form:

$$PE_t = \sum_{j=1}^{\infty} q_{t,j}, \qquad \text{(A.11)}$$

where

$$q_{t,j} = E_t\{\exp[\sum_{i=1}^{j}(-ADR_{t+i-1} + AEG_{t+i})]\} \qquad \text{(A.12)}$$

First note:

$$q_{t,1} = \exp(ADR_t + \mu_{AEG} + \phi_{AEG,AROE}AROE_t + 0.5\sigma^2_{AEG} + AGO_t + 0.5\sigma^2_{AEG,AEV}AEV_t) \qquad \text{(A.13)}$$

The general form of the solution will be:

$$q_{t,j} = \exp(A_j + B_j ADR_t + C_j AGO_t + D_j AEV_t + F_j AROE_t + G_j ADRV_t) \qquad \text{(A.14)}$$

The expressions for the various coefficients are easily found by induction, and follow difference equations, which can be filled in recursively.

Using $q_{t,n+1} = E_t[\exp(-ADR_t + AEG_{t+1})\ q_{t+1,n}]$ and properties of the log-normal distribution, we find:

$$A_{n+1} = \mu_{AEG} + \frac{1}{2}\sigma_{AEG}^2 + A_n + B_n\,\mu_{ADR} + D_n\,\mu_{AEV} + F_n\,\mu_{AROE} + G_n\,\mu_{ADRV} \qquad \text{(A.15)}$$

$$B_{n+1} = -1 + B_n\,\rho_{ADR} + F_n\,\phi_{AROE,ADR} \qquad \text{(A.16)}$$

$$C_{n+1} = 1 + C_n\,\rho_{AGO} + C_n^2\,\frac{\sigma_{AEG}^2}{2} + D_n\,\phi_{AGO} + F_n\,\phi_{AROE,AGO} \qquad \text{(A.17)}$$

$$D_{n+1} = \frac{\sigma_{AEG,AEV}^2}{2} + B_n\big(\phi_{ADR,AEV} + \sigma_{AEG,AEV}\,\sigma_{ADR,AEV}\big) + B_n^2\,\frac{\sigma_{ADR,AEV}^2}{2}$$

$$+D_n\big(\rho_{AEV} + \sigma_{AEV}\,\sigma_{AEG,AEV}\big) + D_n^2\,\frac{\sigma_{AEV}^2}{2} + F_n\sigma_{AROE,AEV}\,\sigma_{AEG,AEV}$$

$$+B_n\,D_n\,\sigma_{ADR,AEV}\,\sigma_{AEV} + B_n\,F_n\,\sigma_{ADR,AEV}\,\sigma_{AROE,AEV} + D_n\,F_n\,\sigma_{AEV}\,\sigma_{AROE,AEV} \qquad \text{(A.18)}$$

$$F_{n+1} = \phi_{AEG,AROE} + F_n\,\rho_{AROE} + F_n^2\,\frac{\sigma_{AROE}^2}{2} \qquad \text{(A.19)}$$

$$G_{n+1} = \frac{1}{2}B_n^2\sigma_{ADR}^2 + \frac{1}{2}G_n^2\sigma_{ADRV}^2 + B_nG_n\sigma_{ADR}\sigma_{ADRV} = \frac{1}{2}(B_n\sigma_{ADR} + G_n\sigma_{ADRV})^2 \qquad \text{(A.20)}$$

Here, $Z_0 = 0$, for Z=A, B, C, D, F, G. The main intuition is mostly quite clear. For example, the B_n coefficients measure discount rate effects and are clearly negative with the persistence of the discount rate playing a large role in determining the total pricing effect. Note that the discount rate volatility effect on prices is positive, which is a pure Jensen's inequality effect. Analogously, the effect of *AGO* on prices should be positive. There are potentially countervailing effects if D_n and F_n are negative. The sign of F_j depends on how ROE affects earnings (which may have negative effects).

The coefficient of D_n is difficult to sign.

First, $D_1 = \frac{\sigma_{AEG,AEV}^2}{2} > 0$. This may be counter-intuitive: uncertainty increases prices, but it is similar to the uncertainty term stressed by Pastor-Veronesi (PV). However, our model is more complex here.

First, because the σ's are positive, there are several additional "Jensen's inequality terms" that strengthen the "PV" effect. It is not clear that $\sigma_{AEG,AEV}$ and $\sigma_{ADR,AEV}$ will be "small", so these terms may be important. They will be counteracted by the positive effect of volatility and the discount rate, which unambiguously cause uncertainty to decrease prices, as $B_j < 0, \phi_{ADR,AEV} > 0, and\ C_j > 0$. They are difficult to sign as they depend on the sign of D_j and F_j and how they interact.

We conclude that if our prior is that uncertainty decreases prices, cash flow uncertainty should substantially increase discount rates ($\phi_{ADR,AEV}$ positive and large).

Modeling Firms

It is straightforward to use the model to explore pricing at the firm level, although we do not fully explore this in this article. We specify a simple firm-specific discount rate and earnings growth rate process:

In particular, for firm i, the firm discount rate follows:

$$FDR_{it} = (1 - \beta_i)r_f + \beta_i ADR_t \tag{A.21}$$

This is a version of the conditional CAPM, assuming a constant interest rate. The firm-specific earnings growth rate follows:

$$FEG_{it} = \gamma_i AEG_t + \sqrt{FEV_{it-1}}\varepsilon_{FEG,it} \tag{A.22}$$

Therefore, a firm is characterized by just two "systematic" exposures: discount rate exposure, β, and cash flow exposure, γ. The cash flow exposure captures both exposures to cash flow level and cash flow variability, *AEV*, because firm-specific cash flow uncertainty is varying through time, and it affects the firm's valuation ratios and firm-specific return volatility. For this model, only one additional state variable would be priced for each firm, namely firm-specific earnings volatility. The aggregate market portfolio and its return and return volatility are thus exposed to aggregate frim-specific earnings variability.

2. Estimation of State Variables

We estimate five state variables: the conditional market variance (ACV), the aggregate discount rate (ADR), the aggregate ROE (AROE), the conditional aggregate variance of the cash flows (AEV), and the growth opportunity variable (AGO). The sample period is from 1986 to 2017 and the regressions are estimated at the quarterly frequency.

2.1 Conditional Market Variance (ACV)

We first define the quarterly realized variance, RV_q^q, as the average of squared daily returns of the World Market Index from Datastream in quarter q. Suppose week w is the last week in quarter q, and month m is the last month in quarter q. Then our benchmark model for the quarterly conditional variance is specified as follows:

$$RV_q^q = a + bVIX_{q-1}^2 + cRV_{q-1}^q + dRV_{q-1}^m + eRV_{q-1}^w + v_q \tag{A.23}$$

The quarterly realized variance, RV_q^q, is projected on the weekly, monthly and quarterly realized variances of daily returns, and the square of CBOE S&P 500 Volatility Index (we use the square of CBOE S&P 100 Volatility Index before 1990, and we scaled the index level by 100) at the end of the previous quarter. All return variances are annualized by multiplying by 250.

The regression results are as follows, with the first row presenting the coefficients and the second row the t-statistics.

a	**b**	**c**	**d**	**e**	**Adj. R^2**
0.010	-0.042	0.272	-0.202	0.446	0.593
4.03	-0.56	2.95	-1.10	7.61	

We use the fitted value of the regression as our measure of ACV. The insignificant coefficient on the VIX is surprising from the perspective of models that use monthly realized variances (see e.g. Bekaert and Hoerova, 2014). However, there is strong correlation between some of the dependent variables and a regression with only the past VIX and past quarterly realized variance does yield a positive and significant coefficient on the VIX.

2.2 Aggregate Discount Rate (ADR)

We compute ADR as the fitted value from the following predictive regression for annual returns:

$$\ln(1 + RET_q) = a + bACV_{q-4} + cADY_{q-4} + d\left(VIX_{q-4}^2 - ACV_{q-4}\right) + u_q \tag{A.24}$$

where RET_q is the return on the Datastream World Market Index over quarters (q-3, q), ACV is the conditional market variance, and ADY is the dividend yield of the Datastream World Market Index.

The regression results are as follows, with the first row presenting the coefficients and the second row the t-statistics.

a	b	c	d	Adj. R^2
-0.201	0.487	11.831	0.256	0.094
-2.56	0.60	3.18	0.57	

The dividend yield appears to be the most important predictor at this frequency. We construct ADR as the fitted value of the regression above.

2.3 Aggregate ROE (AROE)

We focus on global ROE, which is computed as net income (NI) divided by the lagged book value (BV) of the World Market Index from Datastream. *AROE* is the natural logarithm of 1+ROE.

2.4 Conditional Aggregate Variance of Cash Flows (ACV)

To obtain the time-series of this conditional variance, we estimate the following GARCH-in-Mean system using Maximum Likelihood:

$$AROE_q = a + bAROE_{q-4} + cAEY_{q-4} + dACV_{q-4} + eADR_{q-4} + fV_{q-4} + u_q \qquad \text{(A.25)}$$

where $u_q \sim N(0, V_{q-4})$, $V_{q-4} = E_{q-4}[u_q^2] = \exp[\alpha + \beta ln(u_{q-4}^2) + \gamma AEY_{q-4} + \rho ACV_{q-4} + \varphi ADR_{q-4}]$ with AEY_q representing the earnings yield on the World Market Index. The parameters are estimated using the Maximum Likelihood method. The fitted value of V_q is the conditional variance of cash flows.

To obtain parameter starting values for the Maximum Likelihood routine, we proceed as follows:

1) Estimate $AROE_q = a + bAROE_{q-4} + cAEY_{q-4} + dACV_{q-4} + eADR_{q-4} + u_q$;

2) Obtain the residual u from the OLS regression above and then regress $\ln(u_q^2) = \alpha + \beta ln(u_{q-4}^2) + \gamma AEY_{q-4} + \rho ACV_{q-4} + \varphi ADR_{q-4} + \varepsilon_q$ to obtain the starting values for α, β, γ, ρ, φ;

3) use the starting values obtained in 2) and calculate $\widehat{V_{q-4}} = \exp[\alpha + \beta ln(u_{q-4}^2) + \gamma AEY_{q-4} + \rho ACV_{q-4} + \varphi ADR_{q-4}]$, then run $AROE_q = a + bAROE_{q-4} + cAEY_{q-4} + dACV_{q-4} + eADR_{q-4} + f\widehat{V_{q-4}} + u_q$ to obtain the starting value of a, b, c, d, e, f.

The estimation results are as follows, with the first row presenting the coefficients and the second row t-statistics.[16]

[16] We tried several different starting values but this estimation proved to yield the global maximum.

a	b	c	d	e	f
0.040	0.532	-0.250	0.150	0.109	87.298
40.23	57.90	-14.50	6.97	14.48	13.71
α	**β**	**γ**	**ρ**	**φ**	**log likelihood**
-7.495	0.137	16.452	-16.443	-5.555	418.846
-119.07	20.70	14.46	-5.26	-8.53	

2.5 Growth Opportunity (AGO)

We obtain AGO using the following regression:

$$AEY_q = a + bAROE_q + cACV_q + dADR_q + eAEV_q - AGO_q \qquad \text{(A.26)}$$

As defined above, the growth opportunity is the negative of the residual of the projection of global earnings yield on the four state variables. That is, the growth opportunity variable represents the part of the earnings yield that is unrelated to discount rates, cash flows and their variances, and we define it such that it is negatively correlated with the earnings yield.

The regression results are as follows, with the first row presenting the coefficients and the second row the t-statistics.

a	b	c	d	e	Adj. R^2
0.028	0.141	0.276	0.066	4.496	0.379
5.74	3.74	6.89	4.79	0.48	

Both the conditional market variance and the discount rate yield highly significant positive coefficients; higher expected returns decrease earnings yields. The ROE effect can be explained by mean reversion in ROE, which may imply it negatively affects earnings growth.

Table 1. Summary Statistics

This table presents the summary statistics for the firms in each developed market. Column I presents the time-series average of the number of firms in each year. Column II presents the time-series average of the cross-sectional median of MV in US$ millions at quarter end. Column III presents the time-series average of the cross-sectional median of firm IVRET in each quarter. For each firm in each quarter, we calculate its IVRET as the annualized variance of the residuals from the quarterly regression of daily excess returns on global and local Fama-French 3 factors. Columns IV presents the time-series average of country IVRET. For each country in each quarter, we calculate its IVRET as the value-weighted average of firm-level IVRET within the country. The first three rows summarize the average, 25th percentile, and 75th percentile of the respective statistics across countries.

	I	II	III	IV
Country/Region	# of Firms	MV ($millions)	Firm IVRET	Country IVRET
Across Countries				
Average	533	218	0.078	0.050
P25	113	154	0.056	0.043
P75	506	276	0.097	0.062
By Country				
Australia	548	165	0.132	0.052
Austria	74	201	0.047	0.046
Belgium	111	206	0.043	0.035
Canada	779	140	0.145	0.066
Denmark	138	98	0.057	0.049
Finland	118	167	0.082	0.057
France	469	184	0.080	0.053
Germany	401	167	0.057	0.049
Hong Kong	506	168	0.122	0.062
Ireland	43	337	0.082	0.063
Israel	206	172	0.059	0.043
Italy	229	232	0.063	0.043
Japan	2,412	337	0.088	0.072
Netherlands	113	409	0.056	0.034
New Zealand	72	131	0.056	0.038
Norway	124	136	0.097	0.064
Portugal	54	179	0.060	0.049
Singapore	270	157	0.097	0.043
Spain	122	544	0.052	0.034
Sweden	247	154	0.086	0.053
Switzerland	237	276	0.043	0.028
UK	1,009	145	0.057	0.046
US	3,982	308	0.135	0.069

Table 2. Commonality in Country Idiosyncratic Return Variances (IVRET)

This table presents evidence of commonality in country idiosyncratic return variances (IVRET), calculated as the value-weighted firm-level IVRET in each country. Panel A presents the average pairwise correlation and the regression results. Column I (II) presents the average pairwise correlation of country IVRET (market return). For each country, we calculate the pairwise correlations of its IVRET (market return) with the IVRET (market return) of each of the other countries, and present the average pairwise correlation. Market return is the market return in US$ over each quarter. Columns III-V show the regression results of country IVRET on global IVRET, where global IVRET is the value-weighted country IVRET of all countries. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with four lags. Column VI presents the average pairwise correlation of the residuals from this regression. The first three rows summarize the average, 25th percentile, and 75th percentile of the respective statistics across countries. Panel B presents the principal component analysis results. The first row the time-series average of the % of variation in country IVRETs explained by each principal component over 1982-1993, 1994-2005, and 2006-2017. The second row presents the time-series average of the correlation between each principal component and the global IVRET over 1982-1993, 1994-2005, and 2006-2017.

Panel A. Average Pairwise Correlation and Regression of Country IVRET on Global IVRET

	I	II	III	IV	V	VI
Country/	Pairwise Correlation		Regression of Country IVRET on Global IVRET			
Region	IVRET	Market Return	Coef.	t-stat	Adj. R^2	Residual Pairwise Correlation
Across Countries						
Average	0.633	0.583	0.626	6.58	0.548	0.229
P25	0.610	0.556	0.418	2.49	0.364	0.180
P75	0.697	0.624	0.800	8.40	0.774	0.358
By Country						
Australia	0.641	0.606	0.567	2.13	0.364	0.358
Austria	0.616	0.475	0.541	1.76	0.301	0.364
Belgium	0.715	0.616	0.618	2.57	0.526	0.399
Canada	0.720	0.614	0.855	6.84	0.780	0.272
Denmark	0.679	0.594	0.650	8.08	0.694	0.215
Finland	0.313	0.578	0.370	3.40	0.101	0.075
France	0.674	0.643	0.766	12.53	0.789	0.123
Germany	0.635	0.595	0.661	7.46	0.604	0.180
Hong Kong	0.561	0.462	0.660	4.43	0.396	0.198
Ireland	0.657	0.556	1.042	2.49	0.406	0.363
Israel	0.649	0.592	0.252	1.80	0.289	0.395
Italy	0.631	0.570	0.549	7.55	0.583	0.187
Japan	0.608	0.416	0.935	13.17	0.774	-0.107
Netherlands	0.740	0.671	0.633	8.40	0.804	0.340
New Zealand	0.546	0.541	0.169	2.25	0.213	0.327
Norway	0.721	0.578	0.840	5.35	0.677	0.328
Portugal	0.369	0.624	0.214	2.30	0.101	0.171
Singapore	0.610	0.481	0.558	4.38	0.493	0.200
Spain	0.688	0.646	0.381	10.32	0.689	0.201
Sweden	0.684	0.679	0.651	7.02	0.641	0.260
Switzerland	0.697	0.607	0.418	3.45	0.535	0.359
UK	0.736	0.659	0.800	12.37	0.886	0.285
US	0.661	0.606	1.266	21.37	0.954	-0.238

Panel B. Principal Component Analysis of Country IVRETs

	PC 1	PC 2	PC 3	PC 4	PC 5
% Variation Explained	70.1%	8.5%	5.6%	4.3%	2.8%
Correlation with Global IVRET	0.929	0.051	0.204	0.100	0.091

Table 3. Commonality in Firm-Level Idiosyncratic Return Variances (IVRET)

This table presents evidence of commonality in firm-level idiosyncratic return variances (IVRET). Panel A presents the evidence for commonality within country. Column I presents the time-series average of the % of variation explained by the 1st principal component of firm-level IVRET in each country over 1982-1993, 1994-2005, and 2006-2017. Column II presents the median adjusted R^2 of firm-level regressions of IVRET on country IVRET. Column III presents the median adjusted R^2 of firm-level regressions of IVRET on both global and country IVRETs. The first three rows summarize the average, 25th percentile, and 75th percentile of the respective statistics across countries. Panel B presents the evidence for commonality across countries. The first row the time-series average of the % of variation in firm IVRETs explained by each principal component in all countries over 1982-1993, 1994-2005, and 2006-2017. The second row presents the time-series average of the correlation between each principal component and the global IVRET over 1982-1993, 1994-2005, and 2006-2017.

Panel A. Within Country

	I	II	III
Country/Region	% Variation Explained by 1st PC within Country	Median Adj. R^2 (Country)	Median Adj. R^2 (Global and Country)
Across Countries			
Average	38.7%	0.135	0.185
P25	33.2%	0.086	0.139
P75	42.0%	0.188	0.219
By Country			
Australia	41.8%	0.086	0.136
Austria	39.4%	0.106	0.166
Belgium	42.0%	0.196	0.228
Canada	35.8%	0.159	0.207
Denmark	30.5%	0.071	0.113
Finland	39.5%	0.198	0.319
France	26.3%	0.105	0.139
Germany	30.9%	0.045	0.076
Hong Kong	41.2%	0.125	0.166
Ireland	61.3%	0.233	0.322
Israel	50.5%	0.139	0.189
Italy	33.3%	0.186	0.219
Japan	26.9%	0.198	0.217
Netherlands	45.8%	0.205	0.259
New Zealand	45.3%	0.086	0.144
Norway	38.0%	0.141	0.209
Portugal	39.8%	0.056	0.109
Singapore	37.3%	0.160	0.211
Spain	36.6%	0.108	0.164
Sweden	37.6%	0.188	0.229
Switzerland	43.4%	0.138	0.181
UK	33.0%	0.048	0.080
US	33.2%	0.137	0.183

Panel B. Principal Component Analysis of Firm IVRETs across Countries

	PC 1	PC 2	PC 3	PC 4	PC 5
% Variation Explained	25.3%	8.9%	6.8%	5.3%	4.0%
Correlation with Global IVRET	0.705	0.342	0.083	0.098	0.085

Table 4. Commonality in Idiosyncratic ROE Variances (IVROE)

This table presents evidence of commonality in idiosyncratic ROE variances (IVROE). IVROE is transformed using the kernel method. Panel A presents the summary statistics of IVROE and evidence of commonality in country IVROE. Column I presents the time-series average of cross-sectional median of firm-level IVROE for each country. Column II presents the time-series average of country IVROE, which is the value-weighted average of firm-level IVROE within the country. Column III presents the average pairwise correlation of country IVROE. For each country, we calculate the pairwise correlations of its IVROE with the IVROE of each of the other countries, and present the average pairwise correlation. Columns IV-VI show the regression results of country IVROE on global IVROE, where global IVROE is the value-weighted country IVROE of all countries. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with four lags. Column VII presents the average pairwise correlation of the residuals from this regression. Panel B presents the principal component analysis results for country IVROE. The first row the time-series average of the % of variation in country IVROE explained by each principal component over 1982-1993, 1994-2005, and 2006-2017. The second row presents the time-series average of the correlation between each principal component and the global IVROE over 1982-1993, 1994-2005, and 2006-2017. Panel C presents the evidence for commonality in firm IVROE within country and summarize the average, 25th percentile, and 75th percentile of the respective statistics across countries. Column I presents the time-series average of the % of variation explained by the 1st principal component of firm-level IVROE in each country over 1982-1993, 1994-2005, and 2006-2017. Column II presents the median adjusted R^2 of firm-level regressions of IVROE on country IVROE. Column III presents the median adjusted R^2 of firm-level regressions of IVROE on both global and country IVROEs. Panel D presents the principal component analysis results for firm IVROE. The first row the time-series average of the % of variation in firm IVROE explained by each principal component over 1982-1993, 1994-2005, and 2006-2017. The second row presents the time-series average of the correlation between each principal component and the global IVROE over 1982-1993, 1994-2005, and 2006-2017.

Panel A. Commonality in Country IVROE

	I	II	III	IV	V	VI	VII
Country/ Region	Firm IVROE	Country IVROE	Pairwise Corr.	Regression of Country IVROE on Global IVROE			
				Coef.	t-stat	Adj. R^2	Residual Pairwise Corr.
Across Countries							
Average	0.007	0.012	0.138	0.347	2.56	0.203	0.057
P25	0.004	0.009	0.035	0.137	0.46	0.013	-0.036
P75	0.008	0.017	0.247	0.964	4.16	0.312	0.163
By Country							
Australia	0.008	0.010	0.313	0.445	2.83	0.228	0.209
Austria	0.003	0.007	-0.067	-0.095	-0.50	0.003	-0.062
Belgium	0.005	0.009	0.219	0.137	0.58	0.001	0.195
Canada	0.009	0.014	0.303	1.181	4.16	0.547	0.161
Denmark	0.006	0.017	0.066	1.779	3.77	0.258	-0.087
Finland	0.008	0.016	-0.124	-0.602	-2.20	0.064	-0.036
France	0.004	0.008	0.035	-0.018	-0.11	-0.007	0.034
Germany	0.007	0.013	0.119	0.192	1.08	0.011	0.084
Hong Kong	0.007	0.009	0.108	0.342	1.10	0.083	0.017
Ireland	0.006	0.010	-0.035	0.268	2.29	0.042	-0.104
Israel	0.009	0.025	0.273	0.383	0.46	-0.001	0.214
Italy	0.005	0.009	0.098	0.232	1.51	0.069	-0.008
Japan	0.002	0.004	0.268	0.231	6.07	0.461	0.106
Netherlands	0.006	0.012	0.257	0.964	4.27	0.339	0.129
New Zealand	0.003	0.009	0.227	1.151	5.51	0.283	0.075
Norway	0.019	0.027	-0.090	-2.784	-2.94	0.312	0.088

(Continued)

	I	II	III	IV	V	VI	VII
Country/ Region	Firm IVROE	Country IVROE	Pairwise Corr.	Regression of Country IVROE on Global IVROE			
				Coef.	t-stat	Adj. R^2	Residual Pairwise Corr.
Portugal	0.006	0.010	0.216	0.264	1.20	0.013	0.171
Singapore	0.004	0.005	0.247	0.158	1.34	0.052	0.196
Spain	0.004	0.009	0.236	0.385	1.25	0.044	0.163
Sweden	0.012	0.018	0.008	-0.430	-0.97	0.022	0.075
Switzerland	0.003	0.008	0.238	0.748	3.15	0.292	0.103
UK	0.007	0.017	0.141	1.939	10.71	0.764	-0.155
US	0.007	0.018	0.115	1.102	14.33	0.796	-0.252

Panel B. Principal Component Analysis of Country IVROEs

	PC 1	PC 2	PC 3	PC 4	PC 5
% Variation Explained	62.5%	17.4%	7.6%	4.0%	2.9%
Correlation with Global IVROE	0.608	0.530	0.111	0.191	0.293

Panel C. Commonality in Firm IVROEs within Country

	I	II	III
Country/Region	% Variation Explained by 1st PC within Country	Median Adj. R^2 (Country)	Median Adj. R^2 (Global and Country)
Across Countries			
Average	54.8%	0.141	0.376
P25	47.4%	0.117	0.281
P75	57.7%	0.160	0.473

Panel D. Commonality in Firm IVROEs across Countries

	PC 1	PC 2	PC 3	PC 4	PC 5
% Variation Explained	38.3%	28.4%	15.6%	9.0%	5.0%
Correlation with Global IVROE	0.410	0.725	0.269	0.244	0.076

Table 5. Explaining the Global Idiosyncratic Returns Variance (IVRET) using State Variables

This table presents the results of using state variables to explain global idiosyncratic return variance (IVRET). Panel A shows the summary statistics of global idiosyncratic return variance (IVRET) and state variables and their correlations. State variables are estimated using data on the Datastream World Market Index. ACV is the conditional variance of global returns. ADR represents the global discount rate. We calculate ROE as the net income divided by lagged book value and AROE is the natural logarithm of 1+ROE. AEV is the conditional aggregate variance of the cash flows. AGO is the growth opportunity measure. In the correlation matrix, bold denotes significance at the 10% level. Panel B presents the regression results of global IVRET on state variables. T-stats are in parentheses. The last column reports the covariance decomposition results for regression VII.

Panel A. Summary Statistics and Correlations

	Global IVRET	Global IVROE	ACV	ADR	AROE	AEV	AGO
Mean	6.37%	1.39%	1.88%	7.93%	11.34%	0.02%	0.00%
Standard Deviation	3.74%	0.35%	2.12%	5.98%	2.13%	0.01%	0.89%
Correlation with Global IVRET	1	**0.451**	**0.405**	**-0.451**	**-0.168**	0.148	**0.178**

Panel B. Regression of Global IVRET on State Variables

	I	II	III	IV	V	VI	VII	Covariance Decomposition
Global IVROE	5.964						4.590	33.97%
	(6.60)						(6.65)	
ACV		0.729					0.623	23.74%
		(4.91)					(5.72)	
ADR			-0.286				-0.262	31.25%
			(-5.57)				(-6.91)	
AROE				-0.316			-0.326	5.89%
				(-2.06)			(-3.19)	
AEV					61.951		18.951	1.09%
					(1.62)		(0.75)	
AGO						0.762	0.603	4.06%
						(1.95)	(2.38)	
Adj. R^2	0.265	0.164	0.203	0.027	0.014	0.023	0.595	100.00%

Table 6. Cyclicality of Idiosyncratic Variances

This table examines the cyclicality of idiosyncratic variances. Panel A reports the correlation between global idiosyncratic variance measures with business cycle variables. NBER expansion is a dummy variable that is one during an NBER-dated expansion and zero during an NBER-dated recession. GDP growth is the growth rate of trailing 4-quarter global real GDP compared to the same quarter of previous year. Global real GDP is constructed using nominal GDP and GDP deflator data for the OECD total from OECD. The cyclicality measures are measured with a lag of *j* quarters relative to the idiosyncratic variance measures; thus the correlations with positive *j* at the top of each panel measure the extent to which the idiosyncratic variance measure leads the business cycle, whereas the correlations with negative *j* at the bottom measure the extent to which the idiosyncratic measure lags the cycle. Panel B reports the results of regressions of global GDP growth rate on global idiosyncratic variance, lagged global GDP growth rate, and global market return. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with four lags. Panel C presents the summary statistics of the correlation between country idiosyncratic variances and country GDP growth rates. GDP growth is the growth rate of trailing 4-quarter real GDP compared to the same quarter of previous year. We obtain nominal GDP and GDP deflator data for each country from Datastream and OECD. Panel D presents the regression results using alternative business cycle variables. Output gap is computed as the difference between the ln(real GDP) and a quadratic trend, estimated over the full sample. HPGDP is the cyclical component of ln(real GDP) using Hodrick-Prescott (1997) filter, where the smoothing parameter is set to 1600. We regress global cyclicality measure on global idiosyncratic variance, lagged global cyclicality measure, and global market return. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with four lags.

Panel A. Correlation between Global Idiosyncratic Variances and Business Cycle Variables

	I		II		III		IV	
Cycle Variable	NBER Expansion		GDP Growth		NBER Expansion		GDP Growth	
IV Variable	Global IVRET		Global IVRET		Global IVROE		Global IVROE	
Variance Lead (Quarters)	Corr.	p-value	Corr.	p-value	Corr.	p-value	Corr.	p-value
+4	-0.073	0.40	0.254	0.00	-0.014	0.87	-0.137	0.10
+3	-0.185	0.03	0.223	0.01	-0.034	0.69	-0.167	0.05
+2	-0.211	0.01	0.186	0.03	-0.049	0.57	-0.200	0.02
+1	-0.272	0.00	0.128	0.13	-0.071	0.40	-0.235	0.00
0	-0.330	0.00	0.048	0.57	-0.084	0.32	-0.271	0.00
-1	-0.356	0.00	-0.050	0.56	-0.150	0.08	-0.309	0.00
-2	-0.345	0.00	-0.150	0.07	-0.218	0.01	-0.345	0.00
-3	-0.214	0.01	-0.220	0.01	-0.250	0.00	-0.378	0.00
-4	-0.193	0.02	-0.237	0.00	-0.273	0.00	-0.407	0.00

Panel B. Predicting and Explaining GDP Growth

	I		II		III		IV	
	GDP(q+4)		GDP(q)		GDP(q+4)		GDP(q)	
Dep. Var.	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
$IVRET_q$	-0.061	-1.18	-0.023	-0.41				
$IVROE_q$					-0.462	-2.10	-0.415	-1.72
Lag GDP Growth	0.378	3.11	0.388	2.76	0.749	9.34	0.768	8.90
Lag Mkt Ret	0.055	2.64	0.063	2.42	0.015	2.61	0.017	2.76
Adj. R^2	0.284		0.265		0.716		0.711	

Panel C. Correlation between Country Idiosyncratic Variances and Country GDP Growth Rates

	I	II	III	IV	V	VI	VII	VIII	IX
	+4	+3	+2	+1	0	-1	-2	-3	-4
IVRET									
Number of Negative Correlations									
	5	6	7	9	13	19	20	22	22
Number of Negative Correlations Significant at 10% Level									
	2	3	3	3	8	11	15	18	17
IVROE									
Number of Negative Correlations									
	9	10	12	12	13	16	18	19	18
Number of Negative Correlations Significant at 10% Level									
	5	5	6	6	8	9	10	11	13

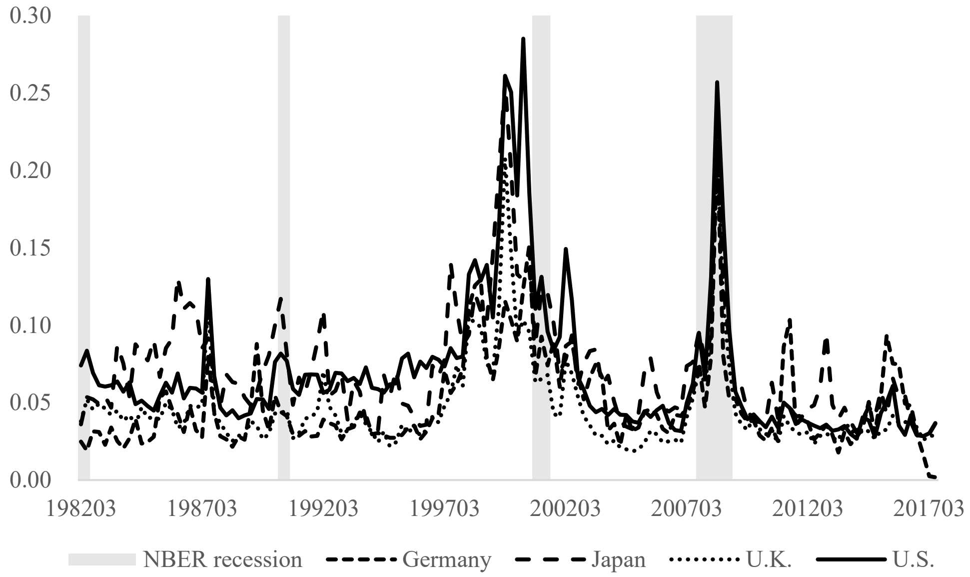
Panel D. Alternative Business Cycle Variables

	I		II		III		IV	
	Output Gap (q+4)		Output Gap (q+4)		HPGDP (q+4)		HPGDP (q+4)	
Dep. Var.	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
$IVRET_q$	-0.080	-1.07			-0.067	-1.12		
$IVROE_q$			0.231	0.88			-0.093	-0.61
Lag GDP Growth	0.787	6.91	0.866	9.80	0.419	2.61	0.686	5.56
Lag Mkt Ret	0.029	1.71	0.017	1.85	0.015	1.21	0.008	1.62
Adj. R^2	0.561		0.740		0.184		0.430	

Figure 1. Time-Series Plot of Country and Global Idiosyncratic Return Variances (IVRET)

This figure presents the time-series plots of country and global idiosyncratic return variances (IVRET). Panel A shows the time-series plots of country IVRET for Germany, Japan, the U.K., and the U.S., which is value-weighted firm-level IVRET within each country. Panel B shows the time-series plot of global IVRET, which is value-weighted country IVRET. The shaded areas represent NBER recession periods.

Panel A. Country IVRET



Panel B. Global IVRET

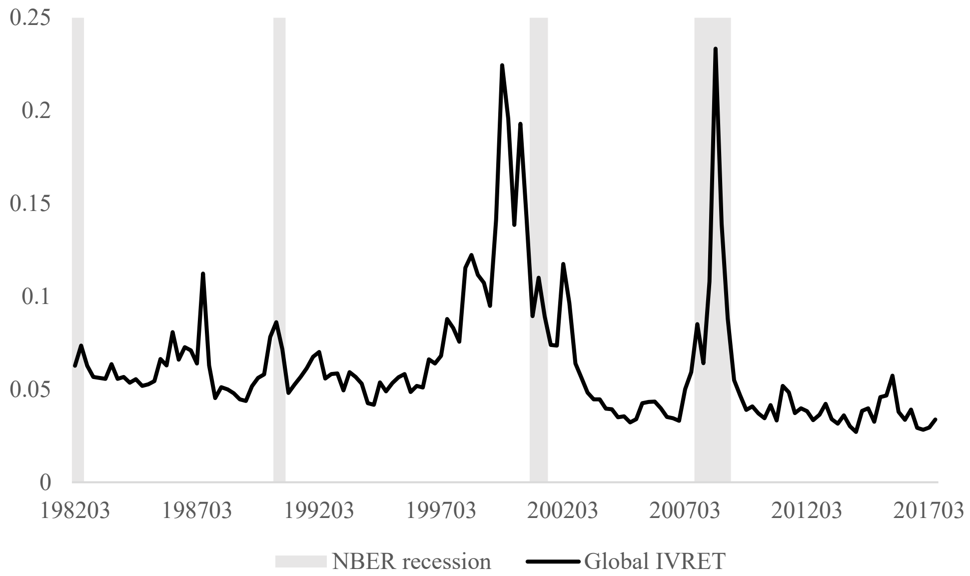
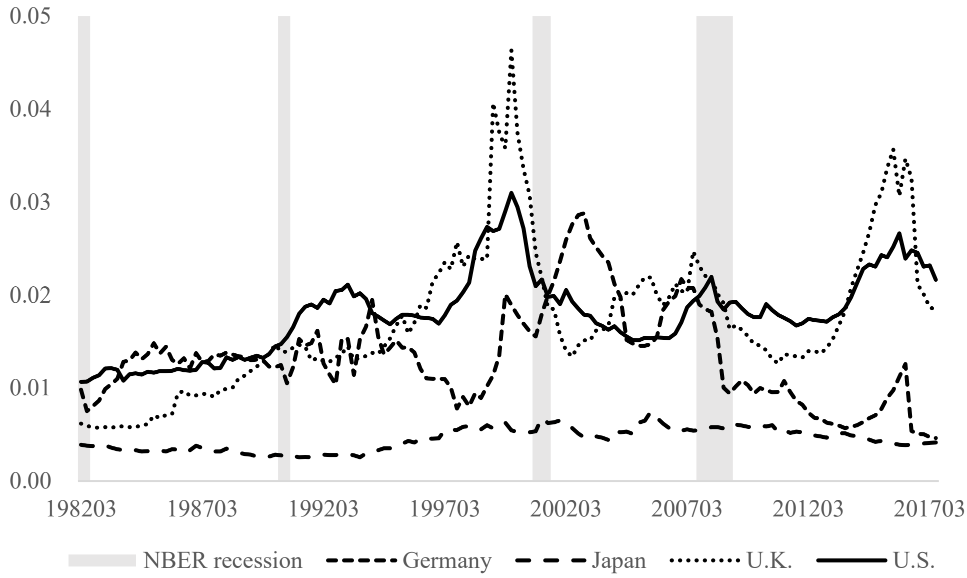


Figure 2. Time-Series Plot of Country and Global Idiosyncratic ROE Variances (IVROE)

This figure presents the time-series plots of country and global idiosyncratic ROE variances (IVROE). IVROE is transformed using the kernel method. Panel A shows the time-series plots of country IVROE for Germany, Japan, the U.K., and the U.S., which is value-weighted firm-level IVROE within each country. Panel B shows the time-series plot of global IVROE, which is value-weighted country IVROE. The shaded areas represent NBER recession periods.

Panel A. Country IVROE



Panel B. Global IVROE

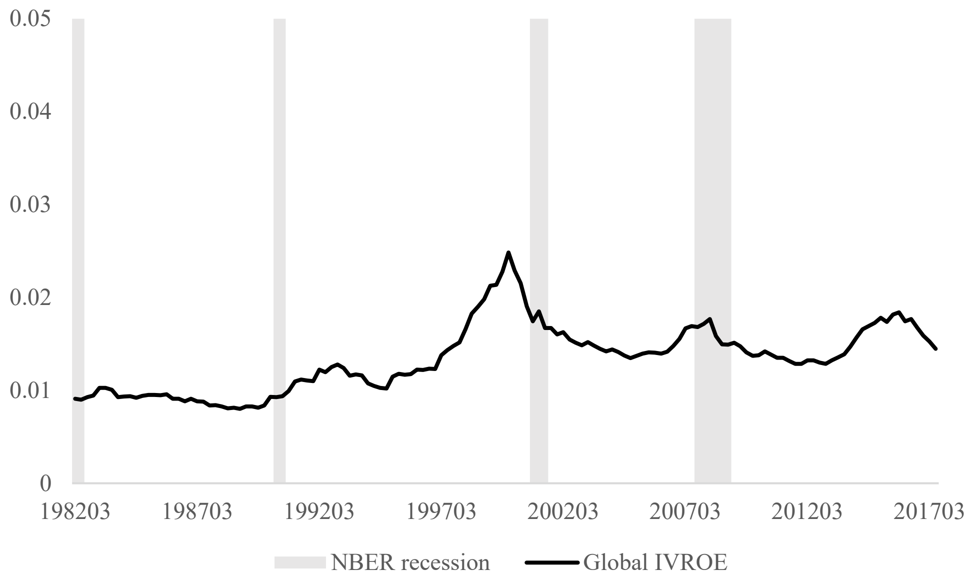
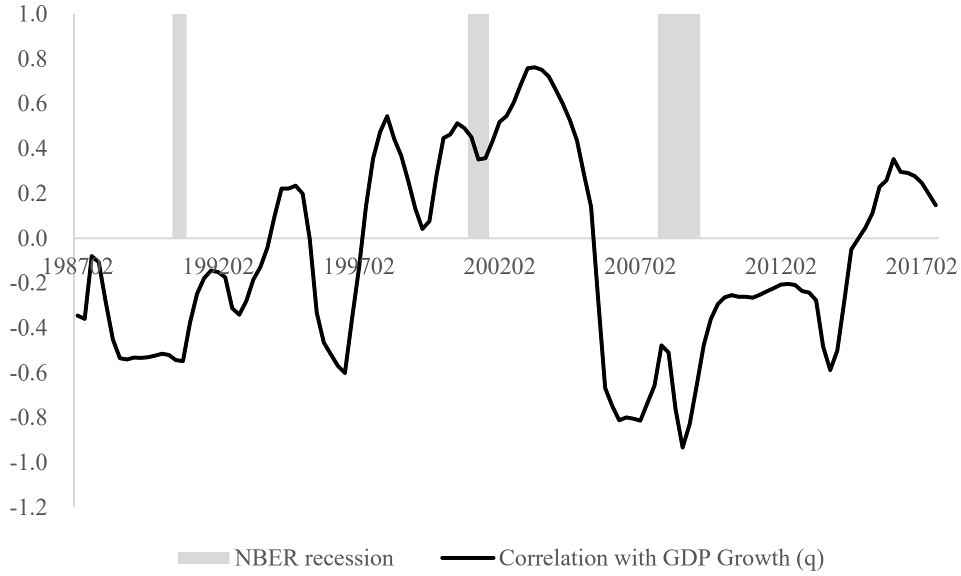


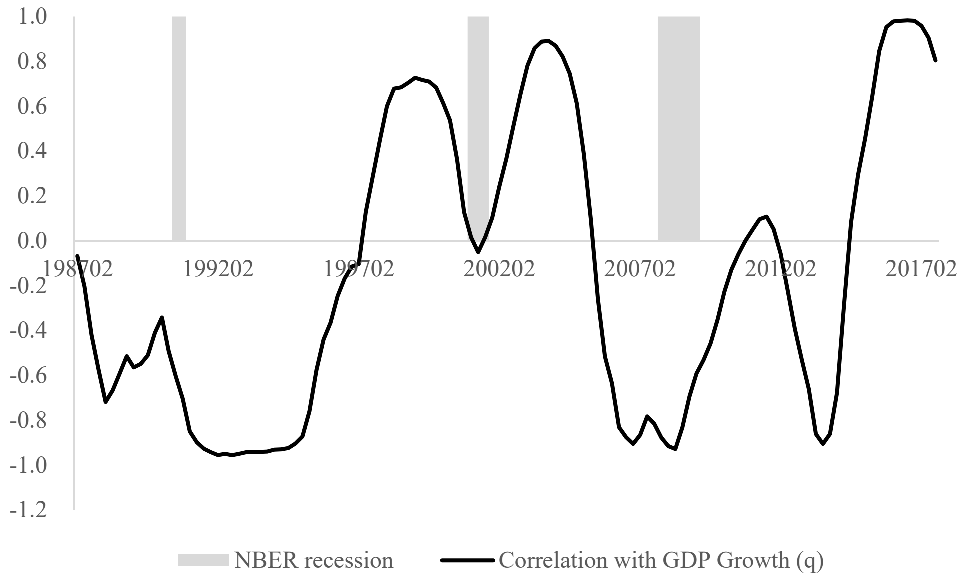
Figure 3. Cyclicality of Global Idiosyncratic Variances

This figure presents the time-series plots of the rolling-window correlation between global idiosyncratic variances and GDP growth rates. In each quarter q, calculate the correlation over the quarters (q-19, q) between global idiosyncratic variance with contemporaneous global GDP growth. GDP growth is the growth rate of trailing 4-quarter real GDP compared to the same quarter of previous year. Global real GDP is constructed using nominal GDP and GDP deflator data for the OECD total from OECD. Panel A shows the time-series plots for global idiosyncratic return variance (IVRET). Panel B shows the time-series plots for global idiosyncratic ROE variance (IVROE). The shaded areas represent NBER recession periods.

Panel A. Global IVRET



Panel B. Global IVROE



Online Appendix

OA-I. Alternative Methods to Estimate Idiosyncratic ROE Variances (IVROE)

We consider seven alternative methods to estimate IVROE.

Methods I-III are based on panel regressions. Specifically, for each country, we estimate the following panel regression:

$$ROE_{iq} = \left(\alpha_{0,i} + a_1 size_{i,q-1} + a_2 BM_{i,q-1}\right) + \left(b_0 + b_1 size_{i,q-1} + b_2 BM_{i,q-1}\right) WMKT_q^{ROE}$$

$$+\left(c_0 + c_1 size_{i,q-1} + c_2 BM_{i,q-1}\right) WSMB_q^{ROE} + \left(d_0 + d_1 size_{i,q-1} + d_2 BM_{i,q-1}\right) WHML_q^{ROE}$$

$$+\left(e_0 + e_1 size_{i,q-1} + e_2 BM_{i,q-1}\right) MKT_{C,q}^{ROE} + \left(f_0 + f_1 size_{i,q-1} + f_2 BM_{i,q-1}\right) SMB_{C,q}^{ROE}$$

$$+\left(g_0 + g_1 size_{i,q-1} + g_2 BM_{i,q-1}\right) HML_{C,q}^{ROE} + u_{iq}^{ROE}$$

where $\alpha_{0,i}$ represents firm fixed effects, and $size_{i,q-1}$ $(BM_{i,q-1})$ is the log size (book-to-market ratio) for firm *i* from the previous quarter *q-1*.

We estimate the panel regression using different windows. Our baseline results in the main text are based on regressions using the full sample period. The alternative Method I estimates the panel regression using 20-quarter rolling window and uses the last quarter's residual, $(u_{iq}^{ROE})^2$, in each rolling window (q-19, q) as IVROE for firm *i* in quarter *q*. Method II uses the variance of u_{iq}^{ROE} in each rolling window (q-19, q) as IVROE for firm *i* in quarter *q*. Method III estimates the panel regression for each 20-quarter nonoverlapping window (1983-1987, 1988-1992, 1993-1997, 1998-2002, 2003-2007, 2008-2012, 2013-2017), and uses $(u_{iq}^{ROE})^2$as IVROE for firm *i* in quarter *q*.

Methods IV-VII are based on firm-level regressions. Specifically, for each firm, we estimate the following time-series regression:

$$ROE_{iq} = \alpha_i + b_i WMKT_q^{ROE} + c_i MKT_{C,q}^{ROE} + u_{iq}^{ROE}.$$

Similar to the panel regression approach, we estimate the firm-level regressions using different windows. Method IV use the full sample period and IVROE for firm *i* in quarter *q* is the squared residual $(u_{iq}^{ROE})^2$. Methods V uses 20-quarter rolling window and uses the last quarter's $(u_{iq}^{ROE})^2$ in each rolling window (q-19, q) as IVROE for firm *i* in quarter *q*. Method VI uses the variance of u_{iq}^{ROE} in each rolling window (q-19, q) as IVROE for firm *i* in quarter *q*. Method VII estimates the firm-level regression for each 20-quarter nonoverlapping window and uses $(u_{iq}^{ROE})^2$as IVROE for firm *i* in quarter *q*.

Table OA1. Estimation of Idiosyncratic ROE Variances (IVROE)

This table presents the summary statistics of ROE factors and the results from the regressions to estimate idiosyncratic ROE variances (IVROE). Panel A presents the summary statistics of ROE factors. For each country at the end of each June, we sort stocks into 3 portfolios based on size or B/M ratio, i.e. Size1, Size2, Size3, B/M1, B/M2, B/M3. The size used to form portfolios in June of year t is market value at the end of June of t. The B/M ratio used to form portfolios in June of year t is book equity for the fiscal year ending in calendar year t-1, divided by market equity at the end of December of t-1. MKT_ROE is the value-weighted ROE of all firms in the sample. SMB_ROE is the difference between value-weighted ROE of firms in Size1 (smallest) and value-weighted ROE of firms in Size3 (largest). HML_ROE is the difference between value-weighted ROE of firms in B/M3 (highest) and value-weighted ROE of firms in B/M1 (lowest). Global ROE factors are value-weighted country-level ROE factors (including countries when they have data available). All statistics are in percent. Panel B presents the coefficients and t-statistics from the following firm-quarter panel regression estimated country by country: $ROE_{iq} = (a_{0,i} + a_1 \times size_{i,q-1} + a_2 \times BM_{i,q-1}) + [b_0 + b_1 \times size_{i,q-1} + b_2 \times BM_{i,q-1}] \times WMKT^{ROE}_q + [c_0 + c_1 \times size_{i,q-1} + c_2 \times BM_{i,q-1}] \times WSMB\_ROE_q + [d_0 + d_1 \times size_{i,q-1} + d_2 \times BM_{i,q-1}] \times WHML\_ROE_q + [e_0 + e_1 \times size_{i,q-1} + e_2 \times BM_{i,q-1}] \times MKT\_ROE_q + [f_0 + f_1 \times size_{i,q-1} + f_2 \times BM_{i,q-1}] \times SMB\_ROE_q + [g_0 + g_1 \times size_{i,q-1} + g_2 \times BM_{i,q-1}] \times HML\_ROE_q + u_{i,q}$ where MKT_ROE, SMB_ROE and HML_ROE are orthogonalized to the global factors. Standard errors are clustered by both firm and quarter. The columns P25, Median and P75 shows the 25th percentile, median and 75th percentile of the statistics across all countries.

Panel A. Summary Statistics of ROE Factors

Country/	MKT_ROE		SMB_ROE		HML_ROE	
Region	Mean (%)	Std Dev (%)	Mean (%)	Std Dev (%)	Mean (%)	Std Dev (%)
Australia	13.71	4.39	-15.85	15.15	-10.29	7.81
Austria	10.12	4.61	-4.40	5.22	-6.37	8.23
Belgium	14.33	4.83	-6.40	6.53	-7.64	6.96
Canada	11.37	4.52	-14.24	11.59	-9.65	7.25
Denmark	18.58	9.35	-13.31	12.40	-15.64	15.89
Finland	16.94	11.06	-10.40	10.54	-16.14	12.88
France	12.92	3.59	-7.42	3.63	-10.71	4.79
Germany	12.28	3.95	-9.20	6.65	-7.98	6.91
Hong Kong	18.12	4.63	-14.05	8.01	-15.27	5.58
Ireland	14.73	6.94	-9.22	9.44	-13.15	10.59
Israel	14.58	5.94	-9.15	7.91	-11.34	8.69
Italy	10.75	4.50	-9.74	5.68	-11.62	6.38
Japan	7.57	3.54	-4.46	2.51	-6.21	3.77
Netherlands	17.74	5.59	-9.94	6.91	-16.55	7.61
New Zealand	15.37	7.36	-11.92	7.91	-18.42	12.35
Norway	14.89	7.90	-11.90	10.76	-14.93	15.57
Portugal	15.16	4.47	-11.46	5.60	-13.88	8.59
Singapore	13.98	3.37	-12.12	4.54	-10.30	4.22
Spain	16.34	5.53	-12.95	9.19	-14.95	7.66
Sweden	18.11	5.43	-13.88	8.72	-10.67	9.48
Switzerland	13.65	4.91	-8.49	5.68	-6.30	5.67
UK	18.68	3.37	-14.02	9.06	-23.28	8.70
US	18.97	3.14	-20.11	5.67	-19.19	5.45
Global	15.53	2.83	-14.51	5.36	-14.74	4.16

Panel B. Regression Results

	P25		Median		P75		U.S.	
Variable	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Size	-0.005	-0.38	0.010	0.78	0.029	3.13	0.017	4.84
BM	-0.045	-3.50	-0.019	-1.55	-0.002	-0.54	-0.138	-8.94
WMKT	-0.117	-0.24	0.410	0.70	1.370	3.35	0.399	2.43
Size×WMKT	-0.024	-0.44	0.051	0.58	0.107	2.38	0.051	2.42
BM×WMKT	-0.238	-2.07	-0.048	-0.68	0.003	0.09	-0.192	-1.96
WSMB	0.171	0.59	0.930	2.15	1.845	4.15	0.977	4.75
Size×WSMB	-0.136	-1.88	-0.059	-0.94	0.054	0.87	-0.048	-1.88
BM×WSMB	-0.307	-3.38	-0.052	-1.94	0.019	0.10	-0.513	-4.18
WHML	-0.573	-1.55	-0.215	-0.80	0.187	0.49	-0.238	-1.27
Size×WHML	-0.035	-0.49	0.015	0.36	0.070	1.17	0.070	3.23
BM×WHML	0.002	0.35	0.045	1.15	0.232	1.65	0.263	2.15
MKT	-0.013	-0.03	0.428	1.41	1.097	3.12	-0.227	-0.84
Size×MKT	-0.018	-0.53	0.033	0.51	0.083	1.43	0.000	0.00
BM×MKT	-0.163	-2.37	-0.028	-0.80	0.015	0.68	0.116	0.71
SMB	0.559	2.52	0.883	4.40	1.181	5.40	0.061	0.35
Size×SMB	-0.139	-4.66	-0.096	-3.04	-0.063	-2.04	-0.025	-1.17
BM×SMB	-0.119	-2.95	-0.048	-1.12	-0.006	-0.49	0.167	1.72
HML	-0.221	-1.64	-0.032	-0.23	0.006	0.03	-0.326	-1.84
Size×HML	0.011	0.64	0.017	0.92	0.035	1.66	0.035	1.66
BM×HML	0.002	0.48	0.024	1.06	0.043	1.51	-0.432	-3.62
Overall R^2	0.421		0.456		0.518		0.514	

Table OA2. Cross-Country Correlations of ROE Residuals

This table presents the average cross-country correlations of ROE residuals. Columns I-III present the results using the panel model. Specifically, for each country, we estimate $ROE_{iq} = (a_{0,i} + a_1 \times size_{i,q-1} + a_2 \times BM_{i,q-1}) + [b_0 + b_1 \times size_{i,q-1} + b_2 \times BM_{i,q-1}] \times WMKT^{ROE}_q + [c_0 + c_1 \times size_{i,q-1} + c_2 \times BM_{i,q-1}] \times WSMB\_ROE_q + [d_0 + d_1 \times size_{i,q-1} + d_2 \times BM_{i,q-1}] \times WHML\_ROE_q + [e_0 + e_1 \times size_{i,q-1} + e_2 \times BM_{i,q-1}] \times MKT\_ROE_q + [f_0 + f_1 \times size_{i,q-1} + f_2 \times BM_{i,q-1}] \times SMB\_ROE_q + [g_0 + g_1 \times size_{i,q-1} + g_2 \times BM_{i,q-1}] \times HML\_ROE_q + u_{i,q}$. Columns IV-VI present the results using the firm regression model. Specifically, for each firm, we estimate $ROE_{iq} = a + b * WSMB\_ROE_q + c * MKT\_ROE_q + u_{i,q}$. We estimate the models using different windows and obtain the residuals $u_{i,q}$, and calculate the country-level value-weighted ROE residual as the value-weighted $u_{i,q}$ within each country. For each country, we report the average pairwise correlation of ROE residuals with the other countries. Column I (IV) reports the results using full sample. Column II (V) reports the results using 20-quarter rolling windows. Column III (VI) reports the results using seven non-overlapping samples of 20 quarters (1983-1987,1988-1992,1993-1997,1998-2002,2003-2007,2008-2012,2013-2017).

	Panel Model			Firm Regression		
	I	II	III	IV	V	VI
Country/ Region	Full Sample	Rolling Window	Non-Overlapping Window	Full Sample	Rolling Window	Non-Overlapping Window
Across Countries						
Average	0.181	0.030	0.065	0.160	0.092	0.200
P25	0.133	-0.012	0.022	0.119	0.033	0.108
P75	0.257	0.073	0.109	0.211	0.145	0.272
By Country						
Australia	0.227	0.076	0.138	0.237	0.168	0.288
Austria	-0.038	0.028	0.086	0.041	0.040	0.059
Belgium	0.237	-0.012	0.089	0.207	0.029	0.164
Canada	0.232	0.049	0.019	0.254	0.087	0.263
Denmark	-0.051	0.005	-0.003	0.077	0.113	0.125
Finland	0.013	0.055	0.109	-0.030	0.086	0.083
France	0.363	0.082	0.142	0.185	0.095	0.204
Germany	0.224	0.035	0.073	0.194	0.154	0.251
Hong Kong	0.257	0.056	0.071	0.020	-0.068	0.016
Ireland	0.165	0.095	0.066	0.154	0.082	0.272
Israel	0.023	-0.015	-0.009	0.240	0.126	0.326
Italy	0.297	-0.019	0.076	0.180	0.189	0.231
Japan	0.230	-0.011	0.049	0.163	0.118	0.301
Netherlands	0.146	-0.061	0.024	0.182	0.063	0.191
New Zealand	0.083	-0.010	0.012	0.020	-0.028	0.039
Norway	0.306	-0.016	0.058	0.201	0.032	0.264
Portugal	0.181	0.129	0.143	0.211	0.112	0.334
Singapore	0.280	0.011	0.074	0.119	0.033	0.108
Spain	0.150	0.073	0.116	0.242	0.137	0.056
Sweden	0.233	0.096	0.118	0.283	0.145	0.242
Switzerland	0.133	-0.070	-0.012	0.132	0.028	0.216
UK	0.269	0.043	0.042	0.176	0.166	0.301
US	0.209	0.059	0.022	0.201	0.200	0.264

Table OA3. Commonality in Firm-Level Idiosyncratic ROE Variances (IVROE)

This table presents evidence of commonality in firm-level idiosyncratic ROE variances (IVROE). Column I presents the time-series average of the % of variation explained by the 1st principal component of firm-level IVROE in each country over 1982-1993, 1994-2005, and 2006-2017. Column II presents the median adjusted R^2 of firm-level regressions of IVROE on country IVROE. Column III presents the median adjusted R^2 of firm-level regressions of IVROE on both global and country IVROEs.

	I	II	III
Country/Region	% Variation Explained by 1st PC within Country	Median Adj. R^2 (Country)	Median Adj. R^2 (Global and Country)
Australia	57.7%	0.230	0.539
Austria	57.0%	0.059	0.256
Belgium	51.7%	0.122	0.346
Canada	42.0%	0.132	0.426
Denmark	47.4%	0.087	0.278
Finland	55.5%	0.125	0.338
France	44.0%	0.151	0.409
Germany	49.0%	0.149	0.481
Hong Kong	56.8%	0.087	0.308
Ireland	71.7%	0.046	0.209
Israel	66.6%	0.215	0.490
Italy	57.5%	0.127	0.281
Japan	40.0%	0.117	0.267
Netherlands	52.7%	0.142	0.356
New Zealand	79.0%	0.226	0.583
Norway	55.1%	0.201	0.473
Portugal	65.4%	0.160	0.340
Singapore	55.1%	0.160	0.412
Spain	59.2%	0.137	0.329
Sweden	55.8%	0.147	0.416
Switzerland	57.4%	0.100	0.270
UK	43.3%	0.156	0.361
US	40.2%	0.172	0.480

Table OA4. Validity of Growth Opportunity Variable (AGO)

This table presents evidence for the validity of growth opportunity variable (AGO) and the regression results using alternative AGO extracted from the market to book ratio (M/B) of Datastream Total Market Index. Panel A presents the regression results of future EBIT growth on AGO. In each quarter, we calculate EBIT of the Datastream Total Market Index as the trailing 4-quarter EBIT. EBIT growth is the growth rate of EBIT over the same quarter of the previous year. AGO is the growth opportunity variable extracted from aggregate earnings yield. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with 10 lags and are shown in parentheses. Panel B presents the regression results of future EBIT growth on the alternative AGO measure extracted from M/B. M/B is calculated as (market value of equity+book value of total assets−book value of total equity)/book value of total assets. AGO is the residual from a regression of M/B on ACV, ADR, AROE, and AEV. The t-statistics are adjusted for serial correlation using Newey and West (1987) standard errors with 10 lags and are shown in parentheses. Panel C presents the results from regressions of global IVRET on the alternative AGO measure and other state variables.

Panel A. Predictability of Future EBIT Growth using AGO

	EBIT Growth$_{t+4}$	EBIT Growth$_{t+5}$	EBIT Growth$_{t+6}$	EBIT Growth$_{t+7}$	EBIT Growth$_{t+8}$
Coefficient	7.655	7.478	5.616	3.193	0.465
t-stat	(2.85)	(2.83)	(2.71)	(1.85)	(0.23)
Adj.R^2	0.178	0.170	0.092	0.024	-0.008

Panel B. Predictability of Future EBIT Growth using Alternative AGO

	EBIT Growth$_{t+4}$	EBIT Growth$_{t+5}$	EBIT Growth$_{t+6}$	EBIT Growth$_{t+7}$	EBIT Growth$_{t+8}$
Coefficient	0.269	0.162	0.038	-0.090	-0.186
t-stat	(1.48)	(0.93)	(0.24)	(-0.58)	(-1.13)
Adj.R^2	0.050	0.012	-0.008	-0.002	0.019

Panel C. Regression of Global IVRET on Alternative AGO and Other State Variables

	I	II	III
Global IVROE	5.964		6.066
	(6.60)		(10.43)
ACV			0.606
			(6.84)
ADR			-0.247
			(-8.00)
AROE			-0.331
			(-3.97)
AEV			23.719
			(1.15)
AGO		0.058	0.094
		(2.79)	(8.11)
Adj. R^2	0.265	0.055	0.732

Table OA5. Explaining the Global Idiosyncratic Returns Variance (IVRET) using State Variables

This table presents the results of using the levels, squares and cross-products of state variables to explain global idiosyncratic return variance (IVRET). State variables are estimated using data on the Datastream World Market Index. ACV is the conditional variance of global returns. ADR represents the global discount rate. We calculate ROE as the net income divided by lagged book value and AROE is the natural logarithm of 1+ROE. AEV is the conditional aggregate variance of the cash flows. AGO is the growth opportunity measure.

	Coefficient	t-stat
Global IVROE	12.933	2.92
ACV	3.320	2.73
ADR	0.711	3.52
AROE	0.176	0.31
AEV	-130.723	-0.97
AGO	-1.942	-1.97
ACV^2	4.938	4.69
ADR^2	0.601	2.85
$AROE^2$	0.393	0.18
AEV^2	118740.220	1.26
AGO^2	61.423	5.16
Global IVROE×ACV	-232.974	-2.82
Global IVROE×ADR	-76.610	-6.47
Global IVROE×AROE	-43.188	-1.15
Global IVROE×AEV	7398.805	0.86
Global IVROE×AGO	176.554	2.81
Adj. R^2	0.834	

Table OA6. Cyclicality of Country Idiosyncratic Variances

This table presents the correlation between country idiosyncratic variances and country GDP growth rates. GDP growth is the growth rate of trailing 4-quarter real GDP compared to the same quarter of previous year. We obtain nominal GDP and GDP deflator data for each country from Datastream and OECD. The GDP growth rates are measured with a lag of *j* quarters relative to the idiosyncratic variance measures; thus the correlations with positive *j* measure the extent to which the idiosyncratic variance measure leads the business cycle, whereas the correlations with negative *j* measure the extent to which the idiosyncratic measure lags the cycle. Negative correlations that are statistically significant at 10% level or lower are indicated in bold. Panel A presents the results for country idiosyncratic return variance (IVRET). Panel B presents the results for country idiosyncratic ROE variance (IVROE). Both IVROE and GDP growth rates are transformed using the kernel method.

Panel A. Country IVRET

Country/	I	II	III	IV	V	VI	VII	VIII	IX
Region	+4	+3	+2	+1	0	-1	-2	-3	-4
Australia	0.138	0.105	0.077	0.048	0.012	-0.021	-0.066	-0.110	-0.138
Austria	0.202	0.173	0.122	0.041	-0.079	**-0.234**	**-0.373**	**-0.448**	**-0.440**
Belgium	0.300	0.254	0.195	0.107	-0.013	**-0.148**	**-0.269**	**-0.316**	**-0.262**
Canada	0.173	0.157	0.119	0.076	0.035	-0.015	-0.065	-0.114	-0.123
Denmark	0.104	0.068	0.019	-0.052	**-0.173**	**-0.274**	**-0.368**	**-0.435**	**-0.425**
Finland	-0.122	**-0.160**	**-0.204**	**-0.263**	**-0.329**	**-0.394**	**-0.450**	**-0.476**	**-0.458**
France	0.388	0.369	0.338	0.295	0.242	0.174	0.110	0.069	0.063
Germany	0.176	0.162	0.122	0.059	-0.021	-0.131	**-0.230**	**-0.294**	**-0.321**
Hong Kong	**-0.182**	**-0.140**	-0.115	-0.126	**-0.182**	**-0.266**	**-0.329**	**-0.382**	**-0.391**
Ireland	-0.082	-0.128	**-0.184**	**-0.245**	**-0.319**	**-0.382**	**-0.425**	**-0.444**	**-0.429**
Israel	0.279	0.284	0.247	0.167	0.043	-0.098	**-0.195**	**-0.245**	**-0.235**
Italy	0.152	0.113	0.077	0.044	-0.015	-0.089	**-0.146**	**-0.166**	-0.130
Japan	0.014	-0.005	-0.031	-0.069	-0.114	**-0.157**	**-0.176**	**-0.170**	**-0.139**
Netherlands	0.397	0.353	0.297	0.226	0.131	0.007	-0.111	**-0.206**	**-0.259**
New Zealand	**-0.254**	**-0.291**	**-0.358**	**-0.419**	**-0.467**	**-0.494**	**-0.478**	**-0.415**	**-0.315**
Norway	0.118	0.068	-0.005	-0.092	**-0.166**	**-0.236**	**-0.305**	**-0.331**	**-0.326**
Portugal	0.383	0.364	0.315	0.245	0.157	0.071	0.010	-0.017	-0.013
Singapore	-0.011	-0.030	-0.059	-0.106	**-0.150**	**-0.221**	**-0.264**	**-0.263**	**-0.226**
Spain	0.364	0.335	0.293	0.245	0.177	0.094	0.013	-0.052	-0.078
Sweden	0.127	0.073	0.009	-0.070	**-0.177**	**-0.275**	**-0.346**	**-0.380**	**-0.347**
Switzerland	0.300	0.266	0.223	0.155	0.051	-0.092	**-0.244**	**-0.365**	**-0.396**
UK	0.122	0.121	0.105	0.068	0.003	-0.068	-0.133	**-0.173**	**-0.163**
US	0.243	0.212	0.177	0.123	0.057	-0.012	-0.089	**-0.144**	**-0.153**

Panel B. Country IVROE

Country/ Region	I	II	III	IV	V	VI	VII	VIII	IX
	+4	+3	+2	+1	0	-1	-2	-3	-4
Australia	0.065	0.027	-0.010	-0.048	-0.086	-0.125	**-0.166**	**-0.208**	**-0.249**
Austria	-0.057	-0.061	-0.066	-0.070	-0.071	-0.068	-0.064	-0.057	-0.052
Belgium	0.044	0.005	-0.040	-0.090	**-0.145**	**-0.202**	**-0.258**	**-0.309**	**-0.351**
Canada	0.266	0.241	0.208	0.168	0.122	0.069	0.013	-0.044	-0.097
Denmark	**-0.199**	**-0.188**	**-0.183**	**-0.179**	**-0.177**	**-0.177**	**-0.176**	**-0.175**	**-0.173**
Finland	**-0.563**	**-0.538**	**-0.515**	**-0.496**	**-0.479**	**-0.465**	**-0.453**	**-0.441**	**-0.427**
France	0.420	0.404	0.384	0.361	0.335	0.308	0.279	0.251	0.225
Germany	0.018	-0.005	-0.036	-0.074	-0.120	**-0.173**	**-0.229**	**-0.285**	**-0.335**
Hong Kong	0.011	0.016	0.017	0.012	0.001	-0.015	-0.035	-0.056	-0.075
Ireland	0.296	0.283	0.268	0.257	0.254	0.262	0.282	0.313	0.353
Israel	0.248	0.207	0.161	0.111	0.060	0.023	-0.015	-0.050	-0.078
Italy	-0.106	-0.104	-0.098	-0.088	-0.075	-0.060	-0.043	-0.023	0.000
Japan	**-0.730**	**-0.724**	**-0.717**	**-0.708**	**-0.698**	**-0.685**	**-0.670**	**-0.652**	**-0.634**
Netherlands	0.375	0.312	0.243	0.168	0.089	0.007	-0.075	**-0.156**	**-0.232**
New Zealand	0.400	0.378	0.358	0.342	0.327	0.312	0.294	0.274	0.249
Norway	0.135	0.092	0.051	0.013	-0.020	-0.048	-0.071	-0.087	-0.098
Portugal	**-0.224**	**-0.272**	**-0.324**	**-0.381**	**-0.443**	**-0.508**	**-0.575**	**-0.640**	**-0.698**
Singapore	0.127	0.115	0.091	0.056	0.014	-0.032	-0.076	-0.114	**-0.143**
Spain	-0.088	-0.137	**-0.184**	**-0.229**	**-0.272**	**-0.313**	**-0.351**	**-0.387**	**-0.418**
Sweden	**-0.164**	**-0.274**	**-0.384**	**-0.489**	**-0.586**	**-0.670**	**-0.738**	**-0.787**	**-0.816**
Switzerland	0.195	0.195	0.191	0.183	0.172	0.157	0.139	0.116	0.089
UK	0.180	0.141	0.097	0.050	0.003	-0.044	-0.087	-0.127	**-0.161**
US	-0.023	-0.055	-0.089	-0.124	**-0.161**	**-0.197**	**-0.230**	**-0.259**	**-0.280**