IPO Vintage and the Rise of Idiosyncratic Risk

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ABSTRACT

This paper presents empirical evidence that the recent rise in idiosyncratic risk is driven by the increasing propensity of firms to issue public equity at an earlier stage in their life cycle. We find that the age of the typical firm at its IPO date has fallen dramatically from nearly 40 years old in the early 1960s to less than 5 years old by the late 1990s. Since younger firms tend to be riskier, this systematic decline in the average age of IPOs, combined with the increasing number of firms going public over the last 30 years, has caused a significant increase in idiosyncratic risk. We show that after controlling for the proportion of young firms in the market, there is no trend in the time series of idiosyncratic risk. Moreover, we find a negative trend in idiosyncratic risk after controlling for other measures of firm maturity.

Owning stock in the average public firm has become increasingly risky over the past 30 years. While the average level of market volatility has not changed substantially, idiosyncratic or firm-specific risk does exhibit a strong positive trend. For example, recent studies by Campbell, Lettau, Malkiel, and Xu (2001) (henceforth CLMX), Malkiel and Xu (2003), Fama and French (2004), Wei and Zhang (2004), and Jin and Myers (2004) document that, over the past 30 years, U.S. public firms exhibit higher firm-specific return volatility, more volatile income and earnings, lower returns on equity, and lower survival rates. The recurring theme in all these studies is that firm risk, however defined, has increased. However, it is not clear whether the systematic trend in firm risk represents a change in the nature of capital markets (for example, changing patterns in transparency, ownership, or trading activity) or a change in the nature of public firms.

In this paper, we offer a simple explanation for the positive trend in idiosyncratic risk that is consistent with a systematic change in the nature of public firms, not public markets. We argue that the rise in firm specific risk can be explained by the interaction of two reinforcing factors: a dramatic increase in the number of new listings and a simultaneous decline in the age of the firm at IPO. We document that the age of the typical firm at its IPO date (measured from its founding date or date of incorporation) has fallen dramatically from nearly 40 years old in the early 1960s to less than 5 years old by the late 1990s. Coupled with a significant increase in the number of firms going public over the same period, there is a steady increase in the proportion of total equity market capitalization represented by young firms. Since the equity of young firms typically represents a claim on cash flows that are further in the future, we argue that the increasing proportion of these firms in the sample could lead to a significant positive trend in aggregate measures of idiosyncratic risk.

Consistent with our hypothesis, we find that the positive trend in idiosyncratic risk documented by CLMX can be fully explained by the proportion of young firms in the market. Perhaps surprisingly, we find that after controlling for age and other measures of firm maturity (e.g., book-to-market, size, profitability, etc.), there is a negative trend in idiosyncratic risk. Overall, our evidence suggests that the recent rise in idiosyncratic risk is driven by the increasing propensity of firms to issue public equity at an earlier stage in their life cycle.

These results are important for several reasons. First, a number of recent studies suggest that idiosyncratic risk may be a priced factor in asset returns. As a result, our study provides a better understanding of the root causes of the systematic change in this priced factor. Second, our results suggest that the increase in the idiosyncratic risk of the average public firm is a simple consequence of the growth and maturity of U.S. capital markets, and does not reflect any systematic change in the nature of markets, ownership patterns, corporate governance, or trading behavior. Finally, to the extent that capital market improvements over the past 30 years (e.g. accounting transparency, market liquidity, and investors access to public equity markets) increase the supply of firms eligible for public equity financing, then the rise in idiosyncratic risk could actually represent improvements in investment efficiency and risk sharing. [1]

[1] Our results also point out the importance of small methodological differences in measuring firm age. While many studies estimate the age of the firm using the number of years in the CRSP files, we instead use the difference between the calendar year of the observation and the firm's founding or incorporation date. We find that using the number of years in the CRSP files as a proxy for firm age can significantly underestimate the age of firms, especially in the early part of the sample.

Our results are related to a number of recent studies. For example, Malkiel and Xu (2002) show that the recent increase in idiosyncratic risk is associated with an increase in institutional ownership. Similarly, Bennett, Sias, and Starks (2003) find that institutions have become more willing to invest in small, risky firms. They argue that all types of institutions have increasingly invested in this type of stocks in search of "greener pastures." Our findings bridge the results in both papers in that we find an increasing predominance of young risky firms, which, if increasingly owned by institutions, draws a connection between institutional ownership and idiosyncratic risk as in Malkiel and Xu (2002). Of course, our analysis does not allow us to separate any causal relation between institutional ownership and idiosyncratic risk. However, if we assume that the lowering of transaction costs allows firms to go public earlier in their life cycle, then it is unlikely that the ownership patterns are having a causal effect on idiosyncratic risk.

Our results are also related to recent work on the time series properties of firm profitability. For example, Fama and French (2004) document a significant increase in the number of new listings after 1979. Further, they find that these new lists have more disperse profitability, higher growth rates, and lower survival rates. Similarly, Wei and Zhang (2004) find a significant deterioration in earning quality and return on equity between 1976 and 2000. These results are reassuring since they suggest that the trend in idiosyncratic risk may be driven by firm fundamentals. However, these studies do not explain why the variance of firm profitability has changed over time. Our findings point to a potentially importance source of the deterioration in firm profitability by providing evidence that firms are simply accessing the public equity markets at an earlier point in their life-cycle when their future viability is more uncertain.

Interestingly, our findings are closely related to Pastor and Veronesi (2003) who argue that uncertainty about future growth rates causes firms to have higher market-to-book ratios and more volatile returns. Consistent with their study, we also find that market-to-book ratios and return variance decline with firm age. Thus, to the extent that the age of the firm at IPO is a proxy for uncertainty regarding future growth rates, our results support Pastor and Veronesi's argument that volatility declines as investors learn more about the profitability of the firm.

The paper proceeds as follows. Section II presents a description of our sample, methods, and a replication of previous evidence on the existence of a trend in idiosyncratic risk. Section III provides evidence that firm age has been declining over the past 30 years. Section IV examines the effect of firm age on idiosyncratic risk. Section V presents some firm-level analysis. Section VI concludes.

II. Sample, Data, and Methodology

A. Sample description

Our study draws on data from a variety of sources. First, we follow CLMX in constructing our aggregate measures of firm specific risk. For these measures, we rely on the CRSP daily and monthly return files and the industry definitions from Fama and French (1997). Our methods, data filters, and summary statistics for idiosyncratic risk are detailed in Section II.B.

Another important variable for our analysis is the age of the firm at IPO. To create this variable, we rely on a dataset constructed by Jovanovich and Rousseau (2001). This dataset details the date of first incorporation and/or original founding date for a large sample of publicly traded firms between 1925 and 1997.[2] In addition to this sample, we have also filled in/supplemented this database using incorporation and founding dates collected from various issues of the Mergent's industrial manual, bank & finance manual, and OTC manual, all published by Moody's Investors Service. We use the earliest available date of the founding date or incorporation date to determine the age of the firm. If these data are unavailable, we consider the age of the firm as a missing value.

In our final sample, we have detailed age at IPO data on 8,482 public firms with 3,949 founding dates and 6,704 incorporation dates over our entire sample period from 1928 to 2003. In all years, the sample of firms for which we have either incorporation or founding dates represents over 90% of the total market capitalization of all NYSE/Amex/Nasdaq firms. The majority of firms that have missing incorporation or founding dates but are in the CRSP/COMPUSTAT databases are small OTC issues.

It is important to note that this methodology differs from the common alternative to determine the age of the firm, which is to use the date of a firm's earliest occurrence on CRSP. Using the first CRSP appearance can induce a significant bias into proxies for firm's age because the age of the typical firm at its IPO date has fallen dramatically over the last forty years. Thus, ignoring this trend can underestimate the age of older firms later in the sample. This bias is particularly severe with the inclusion of Nasdaq firms in the CRSP database in the early 1970s (many of which had existed for many years, but traded on pink sheets).

Finally, we also collect firm specific information (market-to-book, total assets, etc.) from COMPUSTAT. Our final sample consists of all firms for which we have age

[2] These data were collected from a variety of sources. See Jovanovich and Rousseau (2001) for a detailed description of their data collection methods.

at IPO data and that merge with the CRSP and COMPUSTAT databases. Given that our sample period covers a long period of time, summary statistics are not generally informative, but our sample of firms represents the lion's share of the whole market and most of the firm-specific data that we collect is representative of the population with similar means, medians, standard deviations, etc.

B. Construction of firm level volatility.

The focus of our paper is on the time series variation in idiosyncratic, or firm-specific, risk. However there are a number of ways to construct this measure. Of course, one may construct firm-level volatility estimates directly by adjusting total risk for the variation in non-diversifiable risk factors identified from a specific asset pricing model (e.g., the CAPM). The drawback in this approach clearly lies in selecting an asset pricing model that all readers would agree on. Instead, we follow CLMX who propose and indirect method of constructing firm-specific risk. Intuitively, this measure estimates the idiosyncratic risk of a "typical" firm by averaging deviations from market returns over firms within an industry and then averaging the measure over industries. Such an approach is attractive because it avoids having to calculate a large number of betas and covariances. In focusing on the time-series properties for large portfolios of firms, it is unlikely that methodological differences will affect our main results. For example, we note that Bali, Cakici, Yan and Zhang (2004) and Malkiel and Xu (2002) employ different methods to construct a time series of idiosyncratic risk and, while they estimate different levels, they find essentially the same time series patterns as in CLMX. Appendix A provides a brief review of our methodology for constructing $FIRM_t$, our measure of idiosyncratic risk in period t.

Figure 1 presents our estimates of annual and monthly idiosyncratic volatility, $FIRM_t$, for our sample period. The annual (monthly) series is idiosyncratic volatility estimated annually (monthly) from the CRSP monthly (daily) returns file. We report the annual series to examine the behavior of idiosyncratic volatility over a longer period of time. Three casual inferences are apparent. First, idiosyncratic volatility exhibits a negative trend in the 1930s and 1940s after experiencing a spike around the Great Depression of the early 1930s. Second, consistent with the evidence in CMLX, there appears to be a positive trend in idiosyncratic volatility after the early 1960s. Finally, there is a remarkable jump in firm level volatility during the recent "Nasdaq bubble" period of 1998-2001. Indeed, while the mean firm level variance over the entire sample is 0.077, it was almost 2.5 times higher, at 0.190, for the period of Jan. 1998 to Dec. 2000. In the next sub-section we present more formal statistical tests of the time series trend.

C. Trend test results

In this section, we present formal tests of whether there is a trend in firm-specific risk. Our motivation for this analysis is twofold. First, we confirm the findings of previous studies over our sample period. Second, our results in this section provide a benchmark against which to examine the effects of firm age on idiosyncratic volatility.

Given the potential for nonstationarity in the time series that we consider, it is important that we develop trend tests that have appropriate power in the presence of this confounding data property. Vogelsang (1998) proposes a method by which we may determine the confidence bounds around a univariate linear trend with serial correlation of unknown form. The details of our methodology are described in Appendix B but the basic intuition is simple. We estimate a model where our $FIRM_t$ measure depends on a constant and a linear trend as in:

$$FIRM_t = \mu + \beta t + u_t \quad (1)$$

The presence of the trend is simply a rejection of the null hypothesis that $\beta = 0$ and we follow Vogelsang (1998) in constructing the confidence region for our parameter estimates (this is also described in detail in Appendix B).[3]

Table 1 provides the results of our estimation of Equation (1). Panel A reports the results from using the annual series of idiosyncratic volatility. This panel shows that while there is no evidence of a positive trend in idiosyncratic volatility over the period 1928 to 2003, there is some evidence that idiosyncratic volatility has been increasing since the end of World War II. Note that the coefficient of the linear trend is positive and significantly different from zero for the equally weighted measure of idiosyncratic risk. This evidence seems to suggest that the recent increase in idiosyncratic volatility is a phenomenon of the second half of the 20th century (Post-World War II). Panel B reports the results from using the monthly series of idiosyncratic volatility. For comparison with previous findings, we present results for two time periods. The first time period includes our entire sample from July 1962 to October 2003. The second covers the CLMX sample, July 1962 to December 1997. Over the shorter time period, our results are consistent with CLMX. We find a positive and statistically significant (at the 90% level) linear trend in firm level volatility.[4] However, the statistical evidence is somewhat

[3] In addition to the standard trend test, we also performed trend tests (not reported) following Volgelsang (2001). In these tests we allow for a structural break in the series surrounding the Nasdaq bubble period. Overall, our results are qualitatively similar and are not generally sensitive to allowing for other forms of nonstationarity during the late 1990s.

[4] There is a minor typographical error in the reported PS-statistics of CLMX. As a result, the PS-statistics reported here are notably different in magnitude, but not in spirit.

weaker in the equally weighted series than in the value-weighted series since the more volatile properties of the equally weighted series causes our parameters to be estimated less precisely. As expected, in all cases the magnitude of the trend is larger in the equally weighted portfolios than in the value-weighted portfolios suggesting that the trend may be larger for firms toward the lower tail of the size distribution. Over the full sample, the magnitude of the trend increases due to the substantial rise in volatility during the tech bubble period. Overall, the results in Table 1 are consistent with past studies and indicate a positive and significant trend in firm risk over the sample.

III. Time Series Patterns in Firm Age

In the previous section, we report a significant positive trend in idiosyncratic risk that is consistent with the other studies (cited above). In this section, we examine two possible sources of the increase in firm-specific risk. Both sources relate to the time series behavior of new listings of public equity. The first relates to the increasing amount of public equity being issue over time. The second potential source relates to the vintage or age of the firm at the time of IPO. Taken together, we argue that these trends have caused a significant increase in the proportion of total equity market capitalization that is comprised of young firms.

To test whether the nature of the typical public firm has changed over time, we construct a measure of the average age of a firm at the time of its IPO. For this measure, we rely on our age from incorporation or founding date described in Section I. Figure 2 provides a time series of the average and median age of the firm at IPO where age at IPO is measured as the difference between the minimum of the founding or incorporation date and the listing date. The trend in Panel A of Figure 2 is apparent. Before the early

1950s, the average age of firms at IPO appears to be increasing over time in a very volatile way. However, over the past 40 years, there has been a significant and steady decline in the age of the average or median firm at IPO from approximately 40 years in the early 1960s to less than 5 years by 2000. The effect of this is that there is a significant decline in the vintage of IPOs after the early 1960s on a massive scale. Thus, this trend could have a significant effect on estimates of firm risk over the last four decades.

Panel B of Figure 2 presents the number of IPOs in our sample period between 1928 and 2003 for which we have incorporation or founding data. Since our data only represents a sample of all IPOs, we also include data from Ritter (2001) on the total number of IPOs (with an offer price greater than $5) for comparison. Consistent with previous studies, our data show a clear positive trend in the number of IPOs over the sample period, especially since the early 1980s. Further, the time-series properties of our sample closely relate to Ritter's data with a correlation larger than 0.90. Overall, there has been a clear positive trend in the number of firms raising public equity over time with the number of firms going public each year being an order of magnitude larger by the end of the sample period.

These patterns in IPO activity and vintage are not simply an artifact of the increasing role of Nasdaq stocks. In Table 2 we list the number of IPOs in our sample along with the average and median age at IPO for seven five-year periods between 1928 and 2003 by exchange type. Clearly, both listed stocks (NYSE/Amex) and Nadsaq issues both exhibit a significant negative trend in the age at IPO and a positive trend in the number of new listings. Between 1963 and 1972 we have data on 325 new listings on the

NYSE with the median being firm 25 years old at the time of listing. By 1993-2003, the median age of the 587 listings for which we have age data falls by approximately 75% to 6 years. A similar pattern emerges for Nasdaq stocks with at roughly 74% decline in median IPO age (from 19 years old to 5 years old) between the period 1963-1972 and the late 1990s. Clearly, the increase in both the number of IPOs and the decrease in IPO vintage are not driven by a particular market segment or exchange type.

Taken together, these two trends in new equity issues have a reinforcing effect on the characteristics of the average public firm. Since there is a significant increase in the amount of equity raised in public markets over time and a simultaneous decline in the vintage of firms raising equity, there could be a significant change in the amount of total public equity represented by young firms. This is important because is suggests that even a value-weighted measure of idiosyncratic risk may be significantly influenced by the changing nature of the typical public firm over time.

To see the effect that these patterns in IPO behavior have had on the total market, we compute the proportion of the total market capitalization that is represented by "young" firms. Figure 3 presents a time series of data on the proportion of the total market capitalization comprised of "young" firms, where young firms are defined to be any firm that is less than or equal to 10 or 20 years old from the minimum of founding, incorporation, or listing date. Overall, Figure 3 shows that there is a significant positive trend in the proportion of young firms over time between 1962 and 2003. For example, the proportion of total market capitalization represented by firms aged 20 or younger was roughly 5% of the market in the early 1960s and increased six fold to nearly 30% by the late 1990s. More interestingly, it seems that the fraction of young firms in the market is positively correlated with idiosyncratic volatility. In Section IV we investigate the relation between these two variables.

The magnitude of the increase in the fraction of young firms in the market is economically significant. Even in value-weighted portfolios, the shift in total market capitalization representing young firms could have a dramatic effect on the trend in idiosyncratic risk. For example, if the youngest firms are small, high market-to-book, high idiosyncratic risk firms, then this pattern would imply that as the portfolio weight of the entire market shifts towards young firms over time, one would naturally expect to find a positive trend in idiosyncratic risk. That is, the fact that younger firms make up an increasingly large proportion of the total market capitalization over the sample period, coupled with the fact that young firms have higher idiosyncratic risk, means that the entire trend in idiosyncratic risk could simply reflect a change in the portfolio weights given to the series with the higher idiosyncratic risk.

B. The properties of young firms

In the previous sub-section we show that the increasing frequency of new listing coupled with the decrease in the age of the firm at IPO has caused a significant increase in the proportion of young firms over time. We expect, as firms mature, that the market value of the firm increasingly represents a claim on the future stream of earnings from assets in place as opposed to the present value of future growth opportunities. Naturally, this implies that, on average, more mature firms should have lower investment opportunities and idiosyncratic risk. In this section, we briefly describe the characteristics of our sample firm and the relationship between age, risk, and investment opportunities.

In order to test the effect of firm age on various firm characteristics, we form age portfolios conditional on firm size. Age is obviously correlated with the size of the firm and we want to be sure that our focus on firm age is not solely a proxy for firm size. To accomplish this, we begin by first partitioning the sample into deciles based on market capitalization. In order to avoid simply sorting based on time, nominal market values are deflated by the average market value each year before ranking.[5] Each size decile is then partitioned into ten sub-groups based on age deciles. The age of the firm is measured as the difference between the sample year and minimum of the year of the firm's incorporation or founding date. To avoid any distortions in our sample over time, we present results starting in 1974, after the initial introduction of Nasdaq firms into our sample.[6] Decile ranking are formed across all stocks over the entire sample from 1974 to 2003.

For each age-size portfolio we then compute equally weighted cross-sectional averages of idiosyncratic risk as well as various measures of investment opportunities like market-to-book, market value of equity to book equity, and capital expenditures to net property, plant, and equipment. Idiosyncratic risk is measured for each firm as the annualized standard deviation of residuals from a market model regression for each firm based on daily returns each year. Market to book is defined as the sum of market value of equity and the book value of total debt divided by the book value of assets. Market equity to book equity is constructed as the market value of equity divided by the reported book value of shareholders equity. Capital expenditures to net PP&E is based on reported capital expenditures divided by total property, plant and equipment, net of

[5] We also de-trend firm size by the GDP deflator or the PPI before sorting and find similar results.
[6] All of our results are qualitatively similar if we instead start the sample in 1962.

depreciation and amortization expense. Total debt, book assets, book equity, capital expenditures, and net PP&E are collected from COMPUSTAT.

Table 3 presents the univariate statistics on the effect of firm age on the various firm characteristics. As expected, Table 3, Panel A shows a clear relationship between firm age and idiosyncratic risk. For all size deciles, the old firms are significantly less risky than young firms. Even for the largest 10% of the firms, there is a 20% difference in firm-specific risk between the youngest and oldest age deciles.

In Panels B, C, and D of Table 3 we show that the relationship between idiosyncratic risk and firm age is a natural consequence of a firm's changing investment opportunity over its life-cycle. As expected, the age of the firm is negatively related to our three proxies for the present value of future growth opportunities. Independent of firm size, younger firms have a higher market-to-book, a higher market value of equity to book value of equity, and a higher rate of capital expenditures relative to their net PP&E. In each case, the difference between old and young firms is statistically significant in all size deciles.

The differences in investment opportunities between the oldest and the youngest firms are also economically large. For example, Table 3 shows that in the smallest size decile the youngest firms have a 42% higher market-to-book ratio than the oldest firms (2.08 compared to 1.46), a 132% larger market-equity-to-book-equity (3.21 compared to 1.38) and a 61% higher rate of capital expenditures (0.37 compared to 0.23). These findings are consistent with Pastor and Veronesi (2003) who argue that young firms have less certainty over future growth rates, which leads to both higher market-to-book ratios as well as higher firm-specific risk. These results are important because they show that the increasing propensity of firms to issue public equity at an earlier stage of their life-cycle could have the effect of raising the idiosyncratic risk of the typical public firm since the younger firms are naturally riskier on average.

IV. The Effect of Firm Age on the Time Series of Idiosyncratic Risk

In this section we test the hypothesis that the positive trend in the idiosyncratic risk of the typical public firm can be explained by systematic changes in the vintage of the typical public firm. To construct this test, we follow a two-step procedure. First, we regress the level of idiosyncratic volatility at time *t* on our proxies for firm age and collect the residuals from the regression. Second, we perform the same Vogelsang (1998) time-series trend tests from section II.C on the residuals from our first-stage regression. If our hypothesis is correct, then the residuals from the age regression should have no time-series trend.

As a proxy for firm age, we use the proportion of market capitalization of firms between the ages of 0 and 10 years and 0 and 20 years. Table 4 presents the results from the two step approach using value-weighted measures of idiosyncratic volatility. Panel A reports the estimates of the first step regression where idiosyncratic volatility is regressed on our proxies for age. Consistent with the main hypothesis in this paper, we find a positive correlation between idiosyncratic risk and firm age. Note that the coefficient λ_2 is positive and significant in all the first step regressions. Panel B reports the estimates of the second step regression. Interestingly, this panel shows that, after controlling for the proportion of young firms in the market, there is no positive trend in idiosyncratic risk. Note that the coefficient β is not significantly different from zero at the 90% confidence level in any of the regressions. We find similar results when we use equally weighted measures of idiosyncratic volatility. These results are reported in Table 5.

Overall, the evidence in Tables 4 and 5 supports our argument that the positive trend in idiosyncratic volatility documented in previous studies is driven by the increasing number of young firms accessing the public equity markets. This suggests that aggregate idiosyncratic risk has increased because riskier firms (e.g., younger firms) now represent a large fraction of the market, and not because firms have become riskier.

V. Firm-Level Tests

In the previous section we show that controlling for age, there is no evidence of a positive trend in idiosyncratic risk. However, age is only one of many measures of the level of maturity of a firm. Thus, in this section we examine the behavior of idiosyncratic risk over time, controlling for other potential factors that can explain the differences in unique risk between firms. To do this, we estimate a panel data model where the idiosyncratic risk of each firm is regressed on a time trend and several firm characteristics. This analysis allows us to test whether changes in firm characteristics are driving the increase in idiosyncratic risk.

To perform this analysis, we estimate the following regression equation:

$$\begin{aligned} IDIO_{i,t} &= \alpha + \gamma t + \beta_1 AGE_{i,t} + \beta_2 SIZE_{i,t} + \beta_3 MKBK_{i,t} + \beta_4 ROA_{i,t} + \beta_5 EPS_{i,t} \\ &\quad + \beta_6 LEV_{i,t} + \beta_7 DD_{i,t} + \beta_8 I_{Amex} + \beta_9 I_{Nasdaq} + \beta_{10} I_{1987} + \beta_{11} I_{Bubble} + \varepsilon_{i,t} \end{aligned} \tag{2}$$

where *IDIO* is the annualized standard deviation of residuals from a market model regression for each firm based on daily returns each year, *AGE* is the difference between the calendar year of the observation and the firm's founding date or the date of incorporation, *SIZE* is the log of deflated assets, *MKBK* is the market-to-book ratio, *ROA* is the return on assets, *EPS* is the earnings-per-share, *LEV* is the log of one plus the ratio of total long-term debt to total equity, and *DD* is a dummy equal to one if the firm pays dividends, zero otherwise. I_{AMEX}, I_{NASDAQ}, I_{1987}, and I_{BUBBLE} are dummies for Amex firms, Nasdaq firms, the crash of 1987, and the tech bubble of 1998-2000, respectively.

For the purpose of comparison, we present our estimation results in a number of ways. First, we estimate equation (2) using only the constant and time series trend, *t*, as explanatory variables. In addition, we estimate this model both with and without dummy variables (structural break parameters) for the crash of 1987 and the tech bubble period of 1998-2000. The results of these "benchmark" estimations are presented in columns (1) and (2) of Table 6. Whether or not we include the event dummy variables, our simple pooled cross-section/time-series tests find a significant positive trend in idiosyncratic risk over the sample period.

Columns (3) and (4) of Table 6 include the full set of explanatory variables in Equation (2). All of the variables have the expected sign and significance. While it is not surprising that old, large, profitable, high book-to-market, dividend-paying firms listed on the NYSE with little debt tend to have less idiosyncratic risk, it is important to note that the changing cross-sectional properties of these covariates can explain the time-series behavior of idiosyncratic risk. As column (3) shows, once these explanatory variables are included in the regression, the linear time series trend becomes negative and insignificantly different from zero. More interestingly, column (4) shows that when we include the event dummies, there is a significant negative trend in idiosyncratic risk.

Overall, the results in Table 6 are consistent with the aggregate trend test results presented in section IV. Once we control for the fact that the characteristics of listed firms have change dramatically over the sample period, we find no time-series trend in the underlying firm-specific risk measures. In fact, we find some evidence that idiosyncratic risk has declined over time.

VI. Conclusion

In this paper, we show that the rise in idiosyncratic risk over the past 40 years can be explained by the increasing propensity of firms to issue public equity at an earlier stage in their life cycle. Since the equity of young firms represents a claim on cash flows that are further into the future, it is not surprising that the idiosyncratic risk of the typical public firm has increased. Our results also help understand the related declines in earnings quality, return on equity and survival rates over the same period.

Over the past forty years the age of the typical firm issuing public equity has fallen from almost 40 years in the 1960s to less than 5 years by the late 1990s. This trend suggests that U.S. capital markets have shown an increased willingness to purchase equity claims on firms at earlier stages of their life cycle over the last half-century. However, our tests cannot reveal whether this trend is driven by changes in the demand for equity claims on young firms or in the supply of equity claims on young firms. To the extent that the trend is driven by shifting supply, then this may represent an overall decline in the cost of equity capital (at least for young firms) during the last 40 years. Thus, the recent rise in idiosyncratic risk, rather than representing any deterioration in market quality, could actually represent an improvement in capital allocation, risk sharing, and social welfare.

Appendix

A. Construction of the idiosyncratic risk measure.

Our treatment follows closely CLMX who provide a detailed description of their methods. For convenience (and later reference), we briefly summarize the estimation methodology here. Let R_{mt} be the excess market return at time t, R_{it} be the excess return of industry i at time t, and R_{jit} be the excess return of firm j in industry i at time t. The firm returns R_{jit} are readily observable from daily prices and dividends. R_{mt} and R_{it} are computed as:

$$R_{it} = \sum_{j \in i} w_{jit} R_{jit} \tag{3}$$

$$R_{mt} = \sum_{i} w_{it} R_{it} \tag{4}$$

where w_{jit} is the percentage of market capitalization of firm j in industry i, and w_{it} is the percentage of market capitalization of industry i in the market.

The sample volatility of the market at time t, denoted MKT_t, is computed as

$$MKT_t = \sigma_{mt}^2 = \sum_{s \in t} \left(R_{ms} - \mu_{mt} \right)^2 \tag{5}$$

where μ_{mt} is the time t mean excess market return.[7]

We compute the volatility for a particular industry as

$$\hat{\sigma}_{\varepsilon it}^2 = \sum_{s \in t} \varepsilon_{is}^2 \tag{6}$$

where

$$\varepsilon_{is} = R_{is} - R_{ms} \tag{7}$$

[7] This is a slight deviation from CLMX who assume a constant mean market return over the entire sample. We also replicate their methodology and the results are almost identical.

is the industry-specific residual. We then average over industries to obtain average industry volatility:

$$IND_t = \sum_i w_{it} \hat{\sigma}^2_{\varepsilon it} \tag{8}$$

The time t return residual for an individual firm j in industry i is

$$\eta_{jit} = R_{jit} - R_{it} \tag{9}$$

from which we can estimate firm-specific volatility for firm j,

$$\hat{\sigma}^2_{\eta jit} = \sum_{s \in t} \eta_{jis} \tag{10}$$

With the firm-specific volatilities, we can compute the average firm-specific volatility within an industry as

$$\hat{\sigma}^2_{\eta it} = \sum_{j \in i} w_{jit} \hat{\sigma}^2_{\eta jit} \tag{11}$$

Finally, we average over industries to obtain the CLMX measure of average firm variance, $FIRM_t$:

$$FIRM_t = \sum_i w_{it} \hat{\sigma}^2_{\eta it} \tag{12}$$

The firm level returns we examine are from the daily CRSP (Center for Research in Security Prices) tape for the period of July 1962- October 2003. NYSE, AMEX, and NASDAQ traded common shares are included in the sample. The data for interest rates is taken from the CRSP Treasury bill term structure price file. The risk free rate is computed from 30-day Treasury bills. The value-weighted and equal-weighted measures of firm level volatility (FIRM) that we compute are, as expected, almost equal to the measures reported by CLMX. The correlation between our value- and equally weighted series, and their respective series for the overlapping portion of our sample is 0.993 and

0.987, respectively. The minor remaining differences may be attributed to such details as when market capitalization is sampled, the existence of the time-varying mean, or the routine updating of the CRSP data tapes.

In addition to constructing a monthly time-series of idiosyncratic risk from the daily stock files, we also construct a longer annual time series from the CRSP monthly stock files for the period 1928 to 2003. For this series, we follow exactly the same procedure as in the monthly series.

B. Construction of the trend tests

In this appendix, we briefly review our methodology for constructing a test for the presence of a simple univariate linear trend in the time series of idiosyncratic risk. Generally, we follow the Vogelsang (1998) in estimating:

$$v_t = \mu + \beta t + u_t \tag{13}$$

$$u_t = \alpha u_{t-1} + d(L)e_t \tag{14}$$

where v_t is firm-level volatility from Equation (10), μ is the intercept, β is the coefficient on the trend, e is an I(0) white noise process, and

$$d(L) = \sum_{i=0}^{\infty} d_i L^i \tag{15}$$

where L is the lag operator. Confidence bounds around β are established using the methodology in Vogelsang, as in CLMX.

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Table 1
Linear Trends in Idiosyncratic Risk

This table reports the coefficient estimates of the linear trend in idiosyncratic risk for value-weighted and equal-weighted portfolios. The sample consists of the estimated annual average idiosyncratic firm variances (Panel A) and estimated annualized monthly average idiosyncratic firm variances (Panel B). The annual series of idiosyncratic volatility is estimated annually from the CRSP monthly return file. The monthly series of annualized idiosyncratic volatility is estimated monthly from the CRSP daily return file. Variances are estimated using the CRSP dataset for all listed firms. Mean and standard deviation results are unconditional. Linear trend and confidence interval results come from the trend regression $v_t = \alpha + \beta t$ where v_t is the time t estimated annualized monthly average idiosyncratic firm variance for each group. The confidence intervals are the 90% confidence bounds determined by the PS-statistic for a linear time trend due to Vogelsang (1998). Avg. firm risk is the mean estimated idiosyncratic volatility over the relevant sample period. Variation in firm risk is the estimated standard deviation of the series over the relevant sample period.

Panel A: Annual Series

	(1928 - 2003)		(1946-2003)	
	Value Weighted	Equal Weighted	Value Weighted	Equal Weighted
Number of observations	76	76	58	58
Avg. firm risk ($*10^2$)	5.59	17.12	5.36	16.26
St. Dev. firm risk($*10^2$)	3.77	10.68	3.62	9.89
Linear Trend $*10^5$	0.09	0.50	0.91	3.55
Confidence interval	(-3.89, 4.08)	(-27.19, 28.18)	(-0.46, 2.29)	(2.48, 4.62)

Panel B: Monthly Series

	(7/1962 – 12/1997)		(7/1962 – 10/2003)	
	Value Weighted	Equal Weighted	Value Weighted	Equal Weighted
Number of observations	426	426	496	496
Avg. firm risk ($*10^2$)	6.45	32.97	7.68	39.83
St. Dev. firm risk($*10^2$)	2.79	16.83	5.19	26.40
Linear Trend $*10^5$	0.90	11.16	1.26	13.00
Confidence interval	(0.42, 1.37)	(-5.40, 27.73)	(0.004, 2.52)	(3.63, 22.37)

Table 2
Patterns in IPO Vintage 1928-2002

This table presents the patterns in IPO vintage over the period 1928-2002. The age of the firms is constructed as the number of years between initial listing and the minimum of the founding date or the date of first incorporation. Equal-weighted cross-sectional means and annual medians are computed each year using all IPOs for which incorporation or founding data is available. The total number of IPOs used is also provided. The number of IPOs is constructed as the number of new listings on the NYSE, Amex, and Nasdaq.

	Number of IPOs		Average age at IPO		Median age at IPO	
Period	NYSE/Amex	Nasdaq	NYSE/Amex	Nasdaq	NYSE/Amex	Nasdaq
1928-1932	45		35		37	
1933-1942	36		33		28	
1943-1952	79		45		40	
1953-1962	228		33		29	
1963-1972	325	478	35	28	25	19
1973-1982	32	267	38	18	26	11
1983-1992	285	956	24	14	13	6
1993-2002	587	1721	16	11	6	5

Table 3
The Effect of Age on Idiosyncratic Risk and Investment Opportunities: Univariate Analysis

This table presents a comparison of equal-weighted portfolio means for idiosyncratic risk and different measures of investment opportunities by decile of market value of equity and firm age. Portfolios are formed by first partitioning the sample into deciles based on market capitalization. Each size decile is then partitioned into ten sub-groups based on age deciles. Decile ranking are formed across all stocks over the entire sample from 1974-2002. Nominal market values are deflated by the average market value each year before ranking. The age of the firm is constructed as the difference between the sample year and the year of firm's incorporation or founding. Idiosyncratic risk is measured as the annualized standard deviation of residuals from a market model regression for each firm based on daily returns each year. Market to book is defined as the sum of market value of equity and the book value of total debt divided by the book value of assets. Market equity to book equity is constructed as the market value of equity divided by the reported book value of shareholders equity. Capital expenditures to net PP&E is based on reported capital expenditures divided by total property, plant and equipment, net of depreciation and amortization expense. Total assets, book equity, capital expenditures, and Net PP&E are collected from COMPUSTAT. Reported averages are based on equal-weighted cross-sectional means. The significance levels of the differences are based on a two-tailed t-test with a sampling frequency for each cell given by the number of firms in each cell. a, b, and c denote significantly different from zero at the 1%, 5%, and 10% level, respectively.

Panel A: Idiosyncratic Risk

	Smallest size decile	Size decile 4	Size decile 7	Largest size decile
Age Decile				
Youngest	15.08	9.18	7.58	5.23
2	15.51	8.95	7.11	5.17
3	14.22	7.98	6.66	4.89
4	14.71	7.36	5.52	4.12
5	13.45	6.54	5.61	3.70
6	12.33	6.25	5.19	3.85
7	11.49	6.45	4.80	4.07
8	10.91	5.94	4.42	3.96
9	10.65	5.59	4.59	3.80
Oldest	10.05	5.94	4.71	4.17
Difference (10)-(1)	-5.03[a]	-3.24[a]	-2.87[a]	-1.01[c]

Panel B: Market to book

	Smallest size decile	Size decile 4	Size decile 7	Largest size decile
Age Decile				
Youngest	2.08	1.87	1.49	1.15
2	2.09	1.66	1.63	1.42
3	2.13	1.59	1.55	1.13
4	1.61	1.35	1.26	1.14
5	1.29	1.30	1.18	1.10
6	1.17	1.14	1.16	1.12
7	1.12	1.09	0.99	1.16
8	1.07	0.97	1.03	1.27
9	0.99	0.91	1.03	0.99
Oldest	1.46	1.01	1.18	1.09
Difference (10)-(1)	-0.62[a]	-0.86[a]	-0.32[a]	-0.06[c]

Table 3
(continued)

Panel C: Market value of equity to book equity

	Smallest size decile	Size decile 4	Size decile 7	Largest size decile
Age Decile				
Youngest	3.21	2.75	2.70	2.67
2	3.14	2.37	3.12	2.95
3	3.37	2.44	2.68	2.49
4	2.36	2.05	2.21	2.25
5	2.04	1.96	1.91	2.19
6	1.70	1.80	1.94	2.48
7	1.49	1.95	1.61	2.65
8	1.54	1.55	1.78	3.04
9	1.34	1.43	1.85	2.28
Oldest	1.38	1.64	1.93	2.47
Difference (10)-(1)	-1.83[a]	-1.10[a]	-0.77[a]	-0.21[c]

Panel D: Capital expenditures to Net PP&E

	Smallest size decile	Size decile 4	Size decile 7	Largest size decile
Age Decile				
Youngest	0.37	0.35	0.28	0.20
2	0.33	0.31	0.27	0.21
3	0.32	0.30	0.28	0.20
4	0.32	0.28	0.26	0.19
5	0.30	0.26	0.23	0.20
6	0.25	0.24	0.21	0.18
7	0.23	0.24	0.21	0.17
8	0.22	0.23	0.18	0.18
9	0.21	0.21	0.19	0.17
Oldest	0.23	0.22	0.19	0.16
Difference (10)-(1)	-0.14[a]	-0.12[a]	-0.09[a]	-0.04[a]

Table 4
Idiosyncratic Volatility and Firm Age: Value-Weighted Measures of Volatility

This table reports estimates of a two step regression procedure designed to examine the effect of firm age on the time series of idiosyncratic risk. First, we estimate the parameters the following equation:

$$v_t = \lambda_1 + \lambda_2 AGE_t + \varepsilon_t,$$

where v_t is the estimated value weighted average market idiosyncratic volatility at time t, and AGE_t is the proportion of the total market capitalization due to young firms. Then, we regress the residuals from the first regression on a time trend:

$$\hat{\varepsilon}_t = \alpha + \beta t + u_t.$$

Panel A reports the coefficients and Newey-West adjusted t-statistics for the first step regression. Panel B reports the trend coefficient and its Vogelsang (1998) 90% confidence bound for the second step regression. Results are provided for two definitions of young firms: firms between the ages of 0 and 10 years and the ages of 0 and 20 years. The first pair of reported results in each panel uses monthly CRSP data to estimate annual idiosyncratic volatility and market capitalization for each firm for the periods 1928-2003 and 1946 - 2003. The next pair of reported results employ daily CRSP data to estimate the monthly idiosyncratic volatility and market capitalization for each firm for the periods 7/1962 – 12/1997 (the Campbell et. al. 2001 sample period) and 7/1962 – 10/2003.

Panel A: First step regression : $v_t = \lambda_1 + \lambda_2 AGE_t + \varepsilon_t$			
		AGE_t defined as % of market capitalization of firms between the ages of:	
		0-10	0-20
Annual (1928 – 2002)			
	Constant (λ_1)	0.003 (3.354)	0.002 (2.69)
	Age coefficient (λ_2)	0.408 (2.325)	0.247 (2.68)
Annual (1946-2002)			
	Constant (λ_1)	0.002 (4.633)	0.001 (2.940)
	Age coefficient (λ_2)	0.527 (3.528)	0.324 (4.433)
Monthly (7/1962 – 12/1997)			
	Constant (λ_1)	0.001 (1.86)	0.002 (3.43)
	Age coefficient (λ_2)	0.547 (6.113)	0.275 (7.004)
Monthly (7/1962 – 10/2003)			
	Constant (λ_1)	-0.002 (-0.879)	-0.002 (-1.294)
	Age coefficient (λ_2)	1.097 (3.379)	0.593 (5.072)
Panel B: Second step regression : $\hat{\varepsilon}_t = \alpha + \beta\, t + u_t$			
Annual (1928 -2002)			
	Trend coefficient (β)	-0.297	-0.261
	Confidence interval:	(-2.264, 1.668)	(-2.063, 1.54)
Annual (1946-2002)			
	Trend coefficient (β)	0.012	-0.039
	Confidence interval:	(-0.298, 0.322)	(-0.347, 0.270)
Monthly (7/1962 – 12/1997)			
	Trend coefficient (β)	0.151	0.009
	Confidence interval:	(-0.332, 0.633)	(-0.452, 0.470)
Monthly (7/1962 – 10/2003)			
	Trend coefficient (β)	-0.044	-0.589
	Confidence interval:	(-2.186, 2.097)	(-1.891, 0.713)

Table 5
Idiosyncratic Volatility and Firm Age: Equal-Weighted Measures of Volatility

This table reports estimates of a two step regression procedure designed to examine the effect of firm age on the time series of idiosyncratic risk. First, we estimate the parameters the following equation:

$$v_t = \lambda_1 + \lambda_2 AGE_t + \varepsilon_t,$$

where v_t is the estimated equal-weighted average market idiosyncratic volatility at time t, and AGE_t is the proportion of the total market capitalization due to young firms. Then, we regress the residuals from the first regression on a time trend:

$$\hat{\varepsilon}_t = \alpha + \beta t + u_t.$$

Panel A reports the coefficients and Newey-West adjusted t-statistics for the first step regression. Panel B reports the trend coefficient and its Vogelsang (1998) 90% confidence bound for the second step regression. Results are provided for two definitions of young firms: firms between the ages of 0 and 10 years and the ages of 0 and 20 years. The first pair of reported results in each panel uses monthly CRSP data to estimate annual idiosyncratic volatility and market capitalization for each firm for the periods 1928-2003 and 1946 - 2003. The next pair of reported results employ daily CRSP data to estimate the monthly idiosyncratic volatility and market capitalization for each firm for the periods 7/1962 – 12/1997 (the Campbell et. al. 2001 sample period) and 7/1962 – 10/2003.

Panel A: First step regression : $v_t = \lambda_1 + \lambda_2 AGE_t + \varepsilon_t$			
		AGE_t defined as % of market capitalization of firms between the ages of:	
		0-10	0-20
Annual (1928 – 2002)			
	Constant (λ_1)	0.007 (2.826)	0.007 (1.96)
	Age coefficient (λ_2)	0.340 (3.771)	0.261 (3.359)
Annual (1946-2002)			
	Constant (λ_1)	0.002 (3.416)	0.000 (0.113)
	Age coefficient (λ_2)	0.482 (8.432)	0.387 (9.050)
Monthly (7/1962 – 12/1997)			
	Constant (λ_1)	-0.051 (-6.120)	-0.038 (-6.149)
	Age coefficient (λ_2)	2.212 (8.308)	1.409 (8.931)
Monthly (7/1962 – 10/2003)			
	Constant (λ_1)	-0.034 (-3.090)	-0.050 (-7.228)
	Age coefficient (λ_2)	1.900 (6.055)	1.715 (10.120)
Panel B: Second step regression : $\hat{\varepsilon}_t = \alpha + \beta t + u_t$			
Annual (1928 -2002)			
	Trend coefficient (β)	-1.159	-1.126
	Confidence interval:	(-9.53, 7.22)	(-11.27, 9.02)
Annual (1946-2002)			
	Trend coefficient (β)	-0.134	-0.197
	Confidence interval:	(-1.792, 1.524)	(-1.403, 1.009)
Monthly (7/1962 – 12/1997)			
	Trend coefficient (β)	2.323	0.892
	Confidence interval:	(-22.098, 26.744)	(-45.226, 47.009)
Monthly (7/1962 – 10/2003)			
	Trend coefficient (β)	7.353	2.809
	Confidence interval:	(-8.526, 23.234)	(-21.023, 26.642)

Table 6
Panel Data Analysis of Idiosyncratic Risk

This table reports estimates of panel data regressions relating idiosyncratic risk to a time trend and firm characteristics. Idiosyncratic risk is measured as the annualized standard deviation of residuals from a market model regression for each firm based on daily returns each year. Standard errors are reported in parentheses below coefficient estimates. Standards errors have been adjusted for heteroskedasticity.

Dependent Variable	Idiosyncratic Risk			
	(1)	(2)	(3)	(4)
Linear Time Series Trend	0.318	0.297	-0.004	-0.081
	(0.008)	(0.009)	(0.006)	(0.007)
Firm Age			-3.07	-2.96
			(0.586)	(0.572)
Firm Size			-9.336	-9.423
			(0.091)	(0.090)
Book-to-Market			-0.835	-0.885
			(0.069)	(0.069)
Return on Assets			-5.706	-5.740
			(0.102)	(0.102)
Earnings per share			-0.825	-0.846
			(0.073)	(0.073)
Leverage			0.314	0.198
			(0.077)	(0.077)
Dividend Dummy			-11.832	-11.821
			(0.121)	(0.120)
Amex Indicator			-1.048	-1.206
			(0.185)	(0.184)
Nasdaq Indicator			3.314	3.395
			(0.125)	(0.124)
Bubble Dummy		2.220		6.280
		(0.302)		(0.216)
Crash Dummy		3.815		1.030
		(0.363)		(0.248)
Constant	24.340	24.584	38.828	40.318
	(0.208)	(0.217)	(0.192)	(0.195)
N	93,876	93,876	93,876	93,876
Adjusted R-squared	0.012	0.014	0.544	0.548

Figure 1
Firm-Level Volatility

This figure presents idiosyncratic volatility over the period 1928-2003. The annual series is idiosyncratic volatility estimated annually from the CRSP monthly return file. The monthly series is annualized idiosyncratic volatility estimated monthly from the CRSP daily return file.

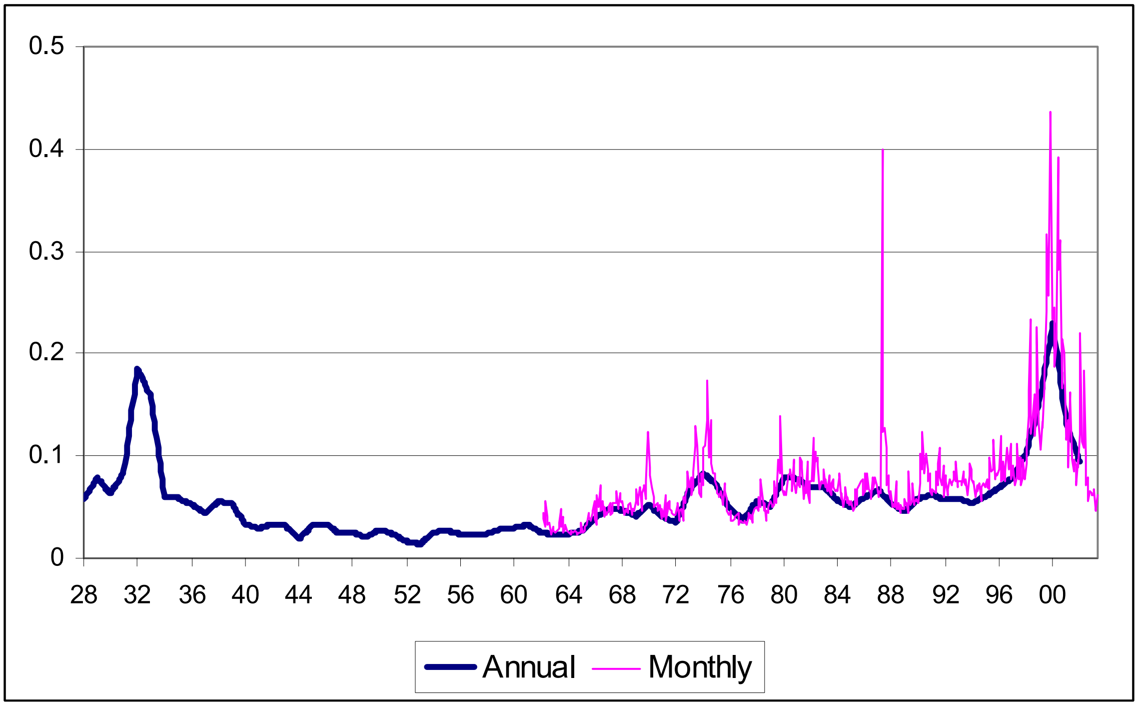
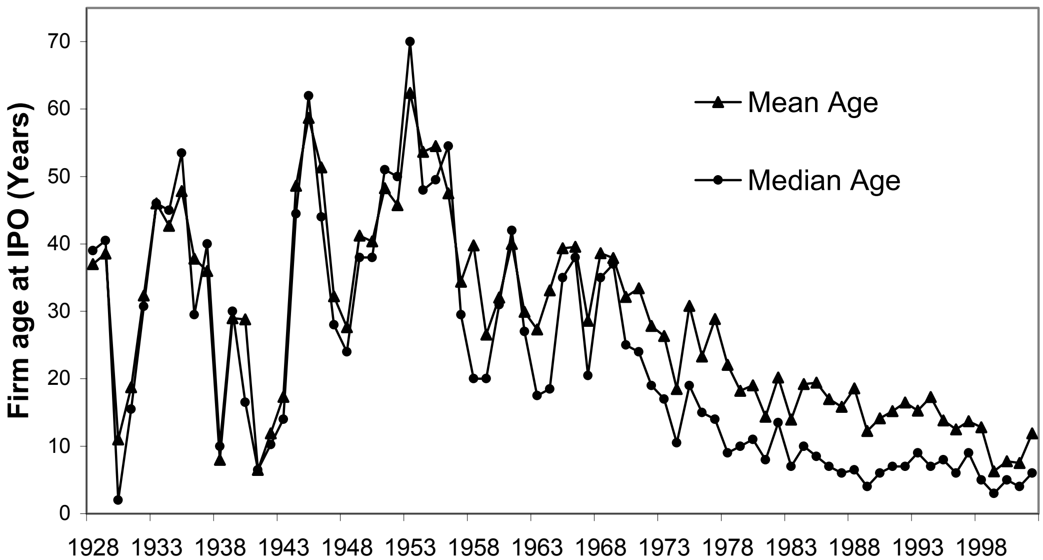


Figure 2
The Age of the Firm at IPO and IPO Activity

This figure presents a time series of the average and median age of a firm at the time of its initial public offering of equity. The age of the firms is constructed as the number of years between initial listing and the minimum of the founding date or the date of first incorporation. Equal-weighted cross-sectional means and annual medians are computed each year using all IPOs for which incorporation or founding data is available. The total number of IPOs used is also provided. The number of IPOs is constructed as the number of new listings on the NYSE, Amex, and Nasdaq.

Panel A: The Age of the Firm at IPO



Panel B: The number of IPOs

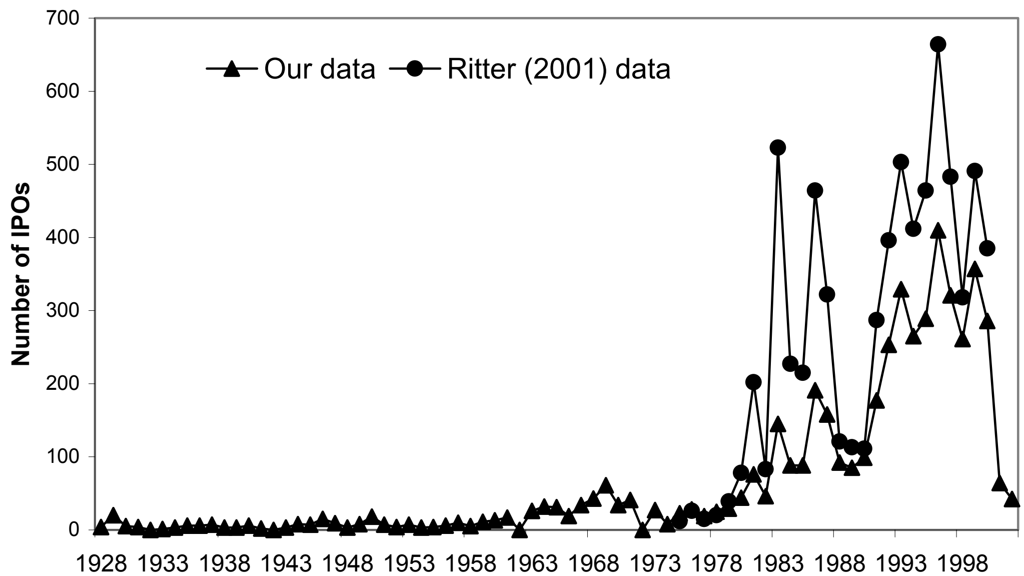
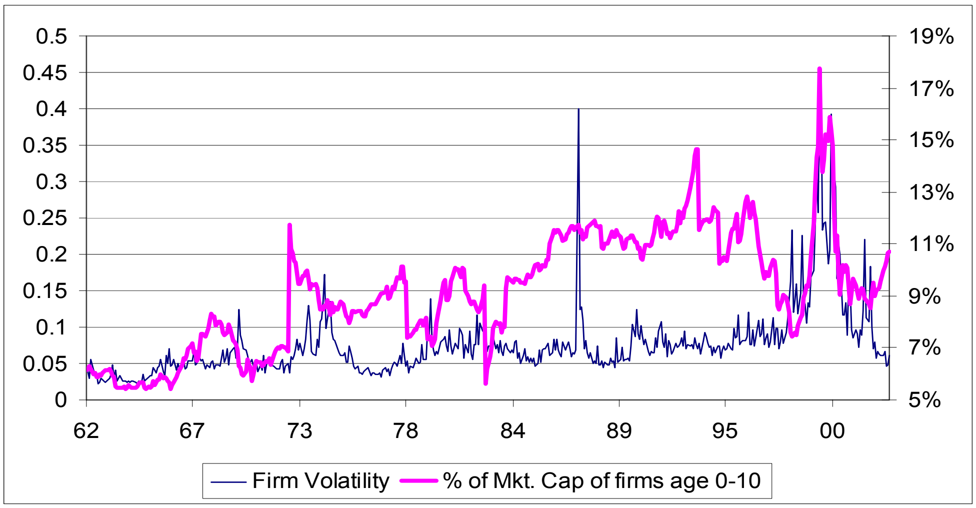


Figure 3
The Market Value of Young Firms and the Trend in Idiosyncratic Risk

This figure presents a time series of the market value of equity of young firms as a proportion of total equity market capitalization and a time series of idiosyncratic risk. The sample includes all CRSP common stocks. Young firms are defined as firms that are less than or equal to 10 years old and 20 years old respectively for each series. Market value is constructed annually as the share price times the number of shares outstanding. Firm age is constructed for each firm year as the difference between the calendar year and the minimum of the listing year, date of first incorporation, or founding date, depending on availability. Volatility is the annualized idiosyncratic volatility estimated monthly from the CRSP daily return file. For each panel, the left axis gives the value of firm volatility, and the right axis gives the proportion of market value of young firms.

Panel A: Young firms defined as 10 years old or younger.



Panel B: Young firms defined as 20 years old or younger.