Why are Successive Cohorts of Listed Firms Persistently Riskier?

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ABSTRACT

Prior studies find that the risk level of each new cohort of listed firms is higher than its predecessors. We find that these risk differences are persistent. We investigate two potential explanations for these findings: (i) each cohort adopts and retains operating innovations that lead to higher risks; and (ii) increasing numbers of younger and less-experienced firms are represented in each new cohort. Our results support the first explanation. Each new cohort uses riskier production technologies and caters to more competitive product markets than its predecessor.

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Prior studies conclude that successive cohorts of initial public offering (IPO) firms exhibit progressively higher risks. Specifically, Fama and French (2004) find that firms listed after 1970 (new-list firms) have lower profitability, lower survival rates, and more volatile profits than firms listed before 1970 (pre-1970 firms). Similarly, stock returns for each new cohort of IPO firms are more volatile than can be explained by multifactor models (Brown and Kapadia 2007). Brown and Kapadia's evidence also suggests that risk differences across cohorts persist (see their Fig. 2, p. 366), a proposition they do not systematically examine. Both studies attribute their findings to over time increases in risk appetite of IPO investors, and thus identify outsiders' decisions as the principal factor for the higher initial risks of successive cohorts. Firms' strategic choices and operating characteristics that differentiate successive cohorts remain unidentified. In particular, it is not clear how successive cohorts operate differently that makes them riskier and less profitable.

We find that the increasing risk across successive cohorts is not just an IPO phenomenon; instead, the risk differences across cohorts persist. For example, the survival rate of each new-list cohort over successive five-year periods remains relatively constant and does not converge on the survival rate of pre-1970 firms. Similarly, the idiosyncratic and earnings volatility of successive cohorts remain distinct over long periods. We examine two potential explanations for this cohort-risk phenomenon. The first is that successive cohorts adopt and retain innovations in their production functions and operate in more competitive product markets that lead to higher risks. We refer to this explanation as the business strategy explanation. The second is that firms in successive cohorts list their stocks at earlier stages of their life cycles, resulting in increasing proportion of young and less experienced firms in each cohort. We call this the early-life-cycle explanation. These two explanations are not mutually exclusive. We find that the long-term

behavior of risk is consistent with the business strategy explanation and not with early-life-cycle explanation. Our study contributes to the literature by showing how the economic environment in which public firms are born, live and die has changed during the past few decades, and how is it associated with higher risks and lower profitability.

The first explanation is derived from the prior literature which examines the potential business strategies of the new firms. Prahalad and Hamel (1990) and Porter (1980) argue that new firms must differentiate their products or achieve cost leadership in order to earn economic rents. Since the 1970s, physical assets have become less distinct and a smaller source of competitive advantage (Zingales 2000), which is evident from a gradual shift in the manufacturing operations from the U.S. to low cost economies (Apte, Karmarkar, and Nath 2008). Thus, new-list firms that start their operation in the U.S. are more likely to offer innovative products and customer-centric services and less likely to compete by being cheaper manufacturer of commodity products (Shapiro and Varian 1998; Payne and Frow 2005; Brickley and Zimmerman 2010; Baumol and Schramm 2010).

In general, innovation and the provision of customer-centric services require more intangible inputs (such as R&D, information technology, databases, and expert human capital) than the manufacture of goods (Apte et al. 2008). Based on this argument, Romer (1998) conjectures that the key resources of new firms are more likely to be software (e.g., patents and formula) and wetware (e.g., human capital) than hardware (e.g., factories and machines). While a firm owns or controls its hardware and software, wetware is the private property of individual employees, who might take it to a rival firm (Romer 1998; Zingales 2000; Zimmerman 2015). In addition, future benefits from intangible investments are less certain than from tangible assets (Kothari, Laguerre, and Leone 2002), intangible investments are positively associated with firm-

specific risks (Comin and Philippon 2005), and R&D-intensive IPOs have higher failure rates than other IPOs (Demers and Joos 2007).

The economic developments are likely to increase the rivalry successive cohorts face in the product markets and the pace at which they launch new products. The U.S. consumer population has shifted toward consumers who rely more on the digitized versions of erstwhile physical products (such as newspapers), have lower brand loyalty, and more frequently demand new products and services (Zeller 2006; Giere 2008; Howe and Strauss 2008; Cudaback 2013). Firms that rely on human capital, intangible inputs, and online delivery mechanisms can more quickly offer innovative products and services than firms that rely on factories, warehouses, and physical distribution networks that take long time to build (Shapiro and Varian 1998). A new firm whose principal resource is knowledge residing with employees can quickly imitate its rival's products by hiring its employees (Cockburn and Griliches 1988). Thus, new cohorts, characterized by more intangible production functions, are likely to face more competitive and rapidly changing market conditions than old cohorts (D'Aveni 1994; D'Aveni 1995; Thomas and D'Aveni 2009).

While these trends in new cohorts' production functions and market conditions can explain why successively listed firms are riskier, these trends do not explain why risk differences across cohorts persist. Stated differently, why don't old cohorts become riskier at the same pace as the successive IPO firms? Explanation for this fact comes from the literature which shows that the firms choose their business strategy relatively early in their lifecycles, and this strategy reflects the technological advances and economic conditions prevalent at the time of firm formation. In the later stages of their lifecycles, firms persist with their legacy business strategies, because even when these strategies become unprofitable, firms cannot easily change

them due to costs of disruptions and technological transitions (Hambrick 1983; Christensen 1997; Yip 2004; Chen et al. 2010). Thus, to the extent that each new cohort adopts more intangible-intensive production technology, addresses more competitive product market, and continues to use its formation business strategy indefinitely, the risk differences across cohorts could persist. This is the main thesis of this paper.

We test our hypotheses using several production and marketing measures. On the production side, we find that successive cohorts are characterized by increasing research and development (R&D) expenditures and rising market-to-book ratios, consistent with an increasing reliance on intangible inputs. Successive cohorts also use declining materials inputs in their production functions, as indicated by the declining percentage of the cost of goods sold (COGS) in their total costs.[1] On the marketing side, new cohorts sell their products and services in more fragmented markets than their predecessors, as measured by the Herfindahl index. Fragmented markets are characterized by intense rivalry and vulnerability to competitors' unexpected actions (Chen et al. 2010). Successive cohorts offer increasingly similar product and services that is likely to lower their pricing power (Hoberg, Phillips, and Prabhala 2014). We create a measure of product launch based on firms' financial information.[2] We find that successive cohorts more frequently launch new products. In addition, each new cohort reports a higher frequency of one-time items such as restructuring charges, asset impairments, and gains or losses on asset sales, consistent with an increasing trend of unexpected and sudden developments in their product markets (Donelson, Jennings, and McInnis 2011).

[1] Firms report the costs of purchasing or manufacturing products (raw materials, labor, and overhead) in the COGS accounts. In contrast, intangible inputs, such as R&D, advertising, brand building, information technology (IT) expenses, and customer relationships are reported in the selling, general, and administrative (SG&A) accounts. Srivastava (2014) argues that COGS and SG&A expenses, measured as percentages of total cost, represent material and intangible intensities, respectively. These outlays constitute approximately 90% of total costs.

[2] We classify a year in which a firm shows seasonally-adjusted quarterly growth in revenues at the top decile of its industry as a successful product launch.

Pre-1970 firms do not seem to fully adopt the operating innovations introduced by successive cohorts. On the production side, pre-1970 firms display relatively stable and low R&D intensities and market-to-book ratios, with material intensities that are consistently higher than those of new-list firms. On the marketing side, pre-1970 firms operate in relatively stable markets that remain highly consolidated and differentiated. Further, their frequency of product launches remains relatively low and they report fewer special items.

Using cross-sectional tests, we find that intangible intensity and market-competitiveness measures are positively associated with growth and risk but are negatively associated with profits. More importantly, the operating differences between new-list and pre-1970 firms persist over long periods and are strongly associated with the differences in risks, profitability, and growth patterns. When new-list firms respond to macroeconomic shocks by temporarily changing their operating practices, their risk differences from post-1970 firms change accordingly. For example, new-list firms reduced their R&D expenditures in the years following 2000 meltdown, but increased them back again in the late 2000s. Differences in their risks from post-1970 firms declined and increased similarly.

We find that the persistent differences in successive cohorts' operating characteristics are sufficient to explain the persistent differences in their risks. Following Brown and Kapadia (2007), we first use multivariate regressions and find that the risk differences across successive cohorts are persistent. We then demonstrate that this cohort-risk phenomenon is attenuated or even eliminated once we control for intangible intensity and product-market characteristics. Thus, we conclude that the adoption of more innovative business strategy by each new cohort and its continued usage explains the cohort-risk phenomenon.

Arguably, the cohort-risk phenomenon can be explained by a well-studied fact—the increasing representation of successive cohorts in intangible-intensive industries (Brown and Kapadia 2007; Ritter and Welch 2002; Srivastava 2014). Indeed we find that the industry composition of the public firms trends toward intangible-intensive industries that display higher risks and lower profits than material-intensive industries. We contribute to the literature by showing that changes in industry composition is not the sole reason for the changing operating characteristic of an average public firm. The successive cohorts within a given industry also have more intangible-intensive production functions and operate in more competitive markets. Thus new cohorts appear to adopt riskier business strategies in order to compete against their established industry counterparts. Our results suggest that new cohorts' overall risk would increase even if the industry composition of public firms were unchanged.

We next examine the early-life-cycle explanation for the cohort risk phenomenon which suggests that newer cohorts list their shares at an earlier stage, before they could demonstrate steady profitability (Ritter and Welch 2002). Jovanovic and Rousseau (2001, p. 337) provide evidence consistent with this explanation. They find that the average waiting time between a firm's incorporation and its listing has declined from approximately 30 years in 1970 to approximately ten years in 2000. They conclude that this change limits the operating and financial reporting history available to investors for evaluating a firm's viability. As a result, public equity investors might fund firms with relatively uncertain prospects.

If the early life-cycle listing were the *only* source for increased risk levels, and the successive cohorts were otherwise similar in their operating characteristics, then the new cohorts' risk levels should decline as firms with unviable projects are delisted. Also, the surviving firms should adopt time-tested operating characteristics of pre-1970 firms as they

mature, thus lowering their risk levels over time mature. Consequently, the average risk and operating characteristics of the surviving firms from new cohorts would converge on that of pre-1970 firms over time. As noted earlier, we find persistent and substantial risk differences across listing cohorts even after several decades. In addition, we find no evidence of convergence of operating characteristics of new-list firms toward those of seasoned firms. In particular, the intangible intensities and product market characteristics of successive cohorts remain distinct.

We therefore conclude that increasing early-stage listing of new firms cannot be the principal reason for the cohort-risk phenomenon. However, this does not rule out the early-stage listing as a related phenomenon if the newer business practices require early listing. For example, new firms might accelerate their listing to beat competitors in exploiting a technology or market development or to attract talented employees who demand early listing for exercising their stock options.

We prima-facie rule out two other explanations for the cohort-risk phenomenon. Increasing financial leverage is an unlikely reason because successive cohorts have decreasing tangibility of assets and profitability that are associated with lower borrowing power (Frank and Goyal 2003). A progressive relaxation of listing standards is also an unlikely reason because after a one-time decline in listing standards in 1970, when NASDAQ opened and attracted many new-list firms, NASDAQ has steadily increased the minimum size requirements (Fama and French 2004).

In sum, our study makes three contributions. First, we systematically test and show that the risk differences across successive listing cohorts persist, as Fig. 2 of Brown and Kapadia (2007) suggests. If these patterns continue, our results suggest that the risks of an average public U.S. firm (adjusting for temporary market-wide factors such as credit crisis in 2008) will increase, not

decline. Second, we show that the increasing riskiness of new cohorts and the persistence of their risk differences over time are consistent with their continued use of innovative business practices they initially adopt and less explained by their early-stage listing. Our findings suggest that any comparison of firm risks across IPO vintages is incomplete if it ignores the differences in production technologies and product market characteristics. Thus, we add to the IPO investors' risk-appetite reason documented by prior studies (arguably, affecting the left hand side of the balance sheet) by documenting operating characteristics that explain the cohort-risk phenomenon (arguably, affecting the right hand side of the balance sheet).

Third, by documenting changes in input technologies and the characteristics of output markets of successive cohorts, we more fully explain the Ritter and Welch (2002) and Fama and French (2004) finding that new new-list cohorts exhibit increasing right-skewness in growth and left-skewness in profits.[3] Our findings suggest that changes over time in the distribution of listed firms' growth and profits are closely linked with contemporaneous changes in new cohorts' business strategies. These findings must interest researchers who examine changes in economic conditions in which public firms are born, live and die.

The rest of the paper proceeds as follows. Section I summarizes the literature and presents the hypotheses. Section II describes sample selection and the measurement of the variables. Section III analyzes the changing industry composition and business characteristics of successive cohorts. Section IV presents results of the hypothesis tests, and Section V presents the concluding remarks.

[3] Intangible investments that are developed within the firm are typically expensed immediately under US generally accepted accounting principles (GAAP). Thus, a growing intangible-intensive firm is likely to report larger losses and fewer balance-sheet assets than a material-intensive firm. Furthermore, intangible-intensive firms typically have higher fixed costs but lower marginal costs than material-intensive firms (Romer 1986; Kaplan et al. 1990). Thus, once an intangible-intensive firm creates its fixed-asset base, it can expand its operations quickly.

I. Prior Research and Hypothesis Development

In this section, we discuss prior research on trends in firm-specific risks and their probable causes.

A. Increases in Firm-Specific Risk over Time

Prior studies document large increases in the last few decades in the average firm-specific risks, measured using volatility in stock returns that cannot be explained by multifactor models (Campbell et al. 2001).[4] These studies generally attribute this trend to changes in firm characteristics, stock market conditions, and macroeconomic conditions. Firm characteristics examined in prior research include research and development expenditures (Comin and Philippon 2005), earnings growth and uncertainty (Malkiel and Xu 2003; Pástor and Veronesi 2003; Wei and Zhang 2006; Zhang 2010), growth options (Cao, Simin and Zhao 2007), financial reporting quality (Rajgopal and Venkatachalam 2010), and expected return variability (Ang et al. 2006). Studies that focus on firms' stock-trading environment examine changes in trading volume (Schwert 2002) and the speculative behavior of investors in low-stock-price firms (Brandt et al. 2010). Other studies examine macroeconomic factors such as business cycles (Brown and Ferreira 2003), product-market competition (Gaspar and Massa 2006; Irvine and Pointiff 2005), and institutional ownership (Malkiel and Xu 2003; Bennett, Sias, and Starks 2003).

These studies implicitly assume that risk increases are pervasive, but Brown and Kapadia (2007) show that increases in overall risk levels can be explained by the risk increases in

[4] Bartram, Brown, and Stulz (2012) summarize reasons for examining firm-specific risks. For example, these risks affect the number of securities required for generating well-diversified portfolios, they increase the misalignment between managers' and shareholders' incentives, and market makers avoid taking positions in stocks with high firm-specific risks. In addition, firm-specific risks might be a priced risk factor (Goyal and Santa-Clara 2003; Ang et al. 2006), though Bali, Cakici, Yan, and Zhang (2005) dispute this proposition. In addition, Roll (1988) laments the low R^2 statistics of standard asset pricing models, which he attributes to high firm-specific risks.

successive listing cohorts. In addition, risk differences across successive cohorts seem to persist (see their Fig. 2, p. 366). Similarly, Fama and French (2004) and Ritter and Welch (2002) find that firms in each cohort grow faster than those in preceding cohorts but are less profitable and have lower survival rates. Prior research does not fully explain the cohort-risk phenomenon, however. Specifically, while Brown and Kapadia (2007) and Fama and French (2004) attribute this phenomenon to changes in investor behavior, they do not identify changes in the operating characteristics of firms in successive cohorts that cause this phenomenon. Thus, we extend Ritter and Welch (2002), Fama and French (2004), and Brown and Kapadia (2007) by identifying firm characteristics associated with increasing risk levels for successive cohorts and investigating why risk differences across listing cohorts are persistent. We examine these questions using two summary measures of risk: a stock-return measure (idiosyncratic volatility) and a financial report-based measure (earnings volatility).

B. Reasons for the Cohort-Risk Phenomenon

We examine two potential explanations for the increasing risks of successive cohorts. The first is that successive cohorts adopt innovations in production technologies and address more competitive product markets, but these new business strategies are not adopted by previous cohorts. And the second is that new cohorts list their shares at earlier stages of their lifecycles than previous cohorts.

B.1. Changes in New Cohorts' Firm Characteristics: Increasing Intangible Intensities

New cohorts' increasing risk could be related to cohort-specific production functions that reflect technological progress and economic conditions when cohorts are formed and their continued usage indefinitely. Several authors document changes in the nature of U.S. firms' economic activities over time. For example, Baumol and Schramm (2010) note that over the last

40 years or so, the United States has become a largely knowledge and services economy, Shapiro and Varian (1998) suggest that the demand for informational products has risen faster than the demand for physical products. Apte, Karmarkar, and Nath (2008, p.15) find that the economy-wide share of companies "involved in the transformation of matter and energy from one form into another" declined from 71% of US gross domestic product (GDP) in 1958 to 37% in 1997 but that the share of companies transforming "information from one pattern into another" increased. In addition, Corrado and Hulten (2010) find that the aggregate expenditures on innovation, marketing, customer support, human capital, computerized data and algorithms, and organizational development by US firms more than doubled from 5.9% of US GDP in the early 1970s to 11.3% in the late 2000s.

Collectively, these studies suggest that direct inputs such as manufacturing cost and COGS constitute a smaller proportion of companies' total costs over time while indirect costs such as R&D make up a higher proportion. Although these changes are likely to affect all firms in the economy, we conjecture that new firms are more likely to adopt intangible-intensive production function than pre-1970 firms for two reasons. First, Prahalad and Hamel (1990) and Porter (1980) argue that new firms must differentiate their business strategy from the incumbent firms to earn economic rents. The competitive strategy for firms starting their operation in the U.S. over the last few decades is more likely to be of offering new products and innovative customer-centric services than to develop cheaper ways to manufacture old products (Shapiro and Varian 1998; Payne and Frow 2005 Baumol and Schramm 2010). Second, new firms have complete flexibility in choosing production technologies. By comparison, the cost and disruption of technological transitions are likely to cause existing firms to continue using production technologies that they chose at their formation (Hambrick 1983; Chen et al. 2010).

Consequently, we expect successive listing cohorts to exhibit progressively higher intangible intensities, consistent with broad changes in economic conditions.

HYPOTHESIS 1: *Successive cohorts exhibit increasing intangible intensity and decreasing material intensity.*

B.2. Changes in the Characteristics of Product Markets Addressed by New Cohorts

Changes in the economy extend to output markets as well. Following Schumpeter (1942), several authors argue that firms face increased competition over time. For example, D'Aveni (1994) claims that firms in "hypercompetitive" environments encounter intense rivalry. Wiggins and Ruefli (2005) examine this claim using large longitudinal firm samples. They conclude that competitive advantage has become substantially harder to sustain across a wide range of industries. Furthermore, they find that sustained competitive advantage increasingly arises from a sequence of advantages instead from a single advantage maintained over time. Hagel et al. (2010) reach similar conclusions. They find that economy-wide returns on invested capital declined from 1965 to 2009. They link this trend to increasing competition as well as to changes in product market features such as a decline in brand loyalty. Consistent with this trend, Thomas and D'Aveni (2009) find dramatic increases in within-industry heterogeneity of returns from 1950 to 2002.

Prior studies also claim that firms more rapidly conduct fundamental innovation and compete in a more aggressive manner in pursuit of growth than before (Shapiro and Varian 1998). This trend should be facilitated by a shift in firms' production functions. A firm that relies on human capital, intangible inputs, and online delivery mechanisms can more quickly introduce a new product than a firm that relies on factories, warehouses, and physical distribution networks, because physical resources take longer time to build (Shapiro and Varian 1998).

None of the above studies, however, examines differences in the characteristics of product markets across listing cohorts. To the extent that new cohorts pursue aggressive business strategies, we expect increasing rivalry and instability in their product markets, resulting in industry fragmentation, which we measure with the Herfindahl index (Hou and Robinson 2006). We also use two financial measures. The first is the frequency of product launches measured using financial information. The second is the frequency of one-off, special items, which represent restructuring charges, asset impairments, and losses from asset sales arising from unexpected developments in product markets (Donelson et al. 2011).

HYPOTHESIS 2*: Successive cohorts exhibit increasing special items and product launches and decreasing Herfindahl indices.*

B.3. Increasing Intangible Intensity and Product-Market Uncertainty as Determinants of Cohort-Risk Phenomenon

Future benefits from investments are less certain for intangible assets than for tangible assets (Kothari, Laguerre, and Leone 2002). Furthermore, R&D expenditure is positively associated with firm-specific risk (Comin and Philippon 2005), and R&D-intensive IPOs have higher failure rates than other IPOs (Demers and Joos 2007). In addition, to the extent that firms' competitive advantage is due to knowledge residing with employees, it can be quickly lost when the firm loses its key employees (Romer 1998; Zingales 2000; Zimmerman 2015). We therefore hypothesize that the increasing risks of successive cohorts are related to their increasing reliance on intangible capital. We also conjecture that the increasing uncertainty of, and rivalry in, product markets addressed by new cohorts is related to the increasing risks of new cohorts.

HYPOTHESIS 3: *The cohort-risk effect becomes insignificant once intangible intensity and characteristics of product markets are accounted for.*

B.4. The Increasing Earliness of Listing of New Firms

Fama and French (2004) find that post-1970 listings display a pattern of higher growth and lower profits than pre-1970 firms. Because both attributes characterize immature firms (Anthony and Ramesh 1992), the increasing riskiness of new cohorts plausibly reflects a shift to listing at early lifecycle stages (Ritter and Welch 2002, p. 1798). Fama and French (2004, p. 233) conjecture: "…firms may come to market earlier in their life cycles, before reaching full profitability." Brown and Ferreira (2003) endorse this view when they conclude that temporal increases in firm-specific risks reflect the relatively high risks of young and small firms. And Jovanovic and Rousseau (2001, p. 337) find that the average waiting time between a firm's incorporation and its listing has declined over time. Yet, IPO firm's age may not perfectly indicate its lifecycle stage because the time to profitability might differ across industries (Audretsch and Feldman 1996; Agarwal and Gort 2002).

We test the early listing hypothesis by examining changes in new-list firms' operating and risk characteristics as cohorts mature. We argue that if the early listing of new firms were the only cause of the cohort-risk phenomenon, then new firms should adopt time-tested operating characteristics of pre-1970 firms as the member firms mature, thus lowering their risk levels over time. Furthermore, if the early listing of new firms, before they could demonstrate their steady-state characteristics, precludes investors from assessing the viability of firm projects, as Jovanovic and Rousseau (2001) suggest, then investors' uncertainty should decline over time as investors obtain additional information on new firms and the unviable firms are delisted. In either case, the average risks and operating characteristics of the surviving firms from new cohorts would converge on those of pre-1970 firms over time. We investigate this potential explanation in Hypothesis 4:

HYPOTHESIS 4: *The operating characteristics and risks of successive cohorts converge with those of pre-1970 firms over time.*

II. Sample Selection, and Measurement of Variables

A. Firm Sample

We use 178,039 firm-year observations with valid data in the Center for Research in Security Prices (CRSP) and Compustat databases from 1970 to 2009.[5] We exclude all finance firms, because the traditional cost classifications [COGS versus selling, general, and administrative (SG&A) accounts] do not apply to those firms.[6] We present the yearly distribution of observations in Table I, Panel A. The listing year is the first year in which a firm has valid data.[7] We classify firms as pre-1970 if they are listed before 1970, and as new-list firms otherwise (Fama and French 2004; and Srivastava 2014). Each cohort of new-list firms is tied to a common decade. Thus, we divide all firms into five groups: pre-1970 firms and cohorts for the 1970s, 1980s, 1990s, and 2000s. We use 40 yearly observations from 1970 to 2009 (requiring Compustat data from 1968 to 2012).

[Insert Table I near here]

A.1. Changes in Composition of the Listed Firm Population

Panel A of Table I describes how the firm population increased from 1,967 firms in 1970 to a peak of 6,530 firms in 1997, reflecting a 3% annual growth rate. The firm population then declined to 3,891 firms in 2009. Each new cohort's contribution to the overall firm population is significant initially, but diminishes over time.

[5] Each firm-year observation requires daily stock-price data for the current year (from CRSP) and asset data for the previous year, along with asset, earnings, and revenue data for the current and next three years (from Compustat).
[6] We exclude Fama–French industries identified by numbers 44–47 (representing finance firms) and 48 (labeled as "almost nothing"), leaving 43 industries, consistent with Srivastava (2014).
[7] We use this method to align our sample selection with the empirical tests. We obtain qualitatively similar results when we use other methods to identify listing years (for example, first appearance in the CRSP database).

B. Measurement of Variables

In this section, we discuss the measurement of key dependent and independent variables. The measurement of each variable is described in the Appendix.

B.1. Idiosyncratic Volatility

We measure idiosyncratic volatility by estimating the Fama–French (1993) three-factor model separately for each firm-month using daily stock-price data (Ang et al. 2006):

$$R_{d,m,y,i} = \alpha_{i,m,y} + \beta_{1,i,m,y} \times (Rm_{d,m,y} - Rf_{d,m,y}) + \beta_{2,i,m,y} \times SMB_{d,m,y} + \beta_{3,i,m,y} \times HML_{d,m,y} + \varepsilon_{d,m,y,i} . \quad (1)$$

We calculate idiosyncratic volatility using the residuals from equation (1) for each firm month as:

$$IV_{m,y,i} = Variance\ (\varepsilon_{d,m,y,i}) . \quad (2)$$

We then average 12 monthly volatilities to calculate annual volatility (*AnnualIV*) and multiply it by 1,000 for expositional reasons.

B.2. Volatility of Earnings

Consistent with Fama and French (2004), we measure *Earnings* (profitability) by annual earnings (Compustat data item IB) scaled by average total assets (Compustat data item AT). We measure the volatility of earnings and operating profit margin (*Earnings Volatility*) for each firm-year using standard deviations of four rolling annual observations (*y* through *y*+3) of the respective variables.

B.3. Intangible and Material Intensity

We measure intangible intensity using R&D (Compustat data item XRD, scaled by average total assets) and *Market-to-Book Ratio* ([Market value of equity (Price {PRCC_F} × Number of shares outstanding {CSHO}) +Total liabilities [Total assets – Shareholder equity

{CEQ})]/Total assets). Consistent with Srivastava (2014), we calculate a firm's material intensity (*COGS Intensity*) using cost of goods sold (Compustat COGS) as a proportion of total cost (revenues [Compustat data item SALE] – earnings).

B.4. Characteristics of Product Markets

We examine four characteristics of the product market that should be related to the uncertainty and rivalry in these markets. First, one-time items (*Special Items;* −1 × Compustat SPI scaled by average total assets) such as restructuring charges, asset impairments, and gains or losses on asset sales, consistent with rapid and unexpected developments in product markets (Donelson, Jennings, and McInnis 2011). Second, a measure of the similarity between a firm's products and those of its rivals, developed by Hoberg, Philips, and Prabhala (2014). This measure, *product-market fluidity*, is based on individual firms' business descriptions from their 10-K filings, and reflects. We obtain firm-year data of product-market fluidity from the coauthors of Hoberg, Phillips, and Prabhala (2014).[8] Third, we measure industry concentration using the Herfindahl index (*H-Index*):

$$H-Index_{j,y} = \sum S_{i,j,y}^2, \quad (3)$$

where S_{ijy} is the revenue share of firm i in industry j in year y. We define an industry by the three-digit standard industrial classification (SIC) code following Hou and Robinson (2006). Fourth, we develop a measure of product launch based on financial information. We classify a year in which a firm shows at least one seasonally-adjusted quarterly growth in revenues at the top decile of its industry as a year of product launch (*product-launch year*). The greater the percentage of product-launch years in a cohort the greater the rivalry in its product markets. Because the percentage of product-launch years remains similar across industries, we compare

[8] These data are available only for 1997 to 2008. Thus, we do not use this variable for the multivariate tests that extend over our entire study period.

rivalry across industries differently. The greater the rivalry in an industry, the higher should be the threshold of seasonally-adjusted quarterly growth (*product-launch threshold growth*) at which a firm-year qualifies for a product-launch year. Thus, we compare rivalry across industries by product-launch threshold growth.

III. Changing Industry Composition and Business Characteristics of Successive Cohorts

In this section, we examine differences in successive cohorts' financial characteristics and industry composition.

A. Changing Financial Characteristics of Successive Cohorts

We estimate the pooled averages of all firm characteristics by cohort-year. The sample is comprised of 140 cohort-year observations: 40 observations each of pre-1970 firms and the 1970s cohort (1970 to 2009), 30 observations from the 1980s cohort (1980 to 2009), 20 observations from the 1990s cohort (1990 to 2009), and ten observations from the 2000s cohort (2000 to 2009). In Figures 1 and 2, we track average idiosyncratic and earnings volatility, respectively, for each cohort by year. Similar to Fig. 2 of Brown and Kapadia (2007), we find that each cohort displays higher risks than its previous cohort. This figure also shows that risks of each cohorts move up and down over time in relation to macroeconomic conditions. For example, firms show higher risks after the 2000s meltdown and during the credit crisis of 2008. However, the lines depicting cohort risks rarely intersect indicating that the risk differences across cohorts persist for long time.

[Insert Figures 1 and 2 near here]

In Panel B of Table I, we present the overall average of financial characteristics of each listing cohort by averaging its cohort-year observations. We also present the test of differences between the average characteristics of successive cohorts. The results show that the risk levels of

successive cohorts increase and their profitability declines, and both trends are monotonic. The idiosyncratic volatility measures (× 1000) from the earliest to the latest cohorts are 0.542, 0.881, 1.438, 1.560, and 1.601; and the corresponding earnings volatility are 0.031, 0.046, 0.101, 0.119, and 0.134. The profitability measures are 0.044, 0.037, −0.048, −0.087, and −0.163. In most cases, the differences between the characteristics of the successive cohorts are statistically significant.

B. Across- and Within-Industry Differences of Successive Cohorts

Before testing our hypotheses, we examine changes in industry composition across listing cohorts and changes in average characteristics of new-list firms within industries. Our goal is to determine whether the average characteristics of pre-1970 and new-list firms would differ even if industry composition were unchanged. We first classify all firm-year observations into pre-1970 and new-list categories and then further categorize them into 43 industries using the Fama and French 48-industry classification. The top three industries (with the highest number of firm-year observations) in the pre-1970-firm category are utility, retail, and machinery, and those in the new-list firm category are business services, electronic equipment, and pharmaceuticals. The former set of industries appears to be relatively material- and energy-intensive, and the latter appears to be knowledge-intensive. We test this notion by estimating the average intangible and material intensities of these six industries using pooled firm-year data from 1970 to 2009.

Consistent with our expectations, the average R&D expenditures of the top three industries in the new-list firm category are 0.081, 0.100, and 0.293 but only 0.000, 0.000, and 0.022 for the pre-1970 firms category (Panel A of Table II). In contrast, the COGS measure of material intensity of the top three industries in the pre-1970 firm category are 0.785, 0.713, and 0.725, much higher than the comparable new-list firms' values of 0.504, 0.584, and 0.592. We

find similar results when we measure intangible and material intensities over common periods across cohorts. We also find similar result by top five industries instead of top three (results not reported). These results support the view that the industry composition of the listed population has shifted from material-intensive to intangible-intensive industries with each new listing cohort.

[Insert Table II near here]

We next examine whether the average characteristics of the listed population would change over time even if industry composition were held constant. We estimate the average characteristics of firms by listing cohort in each of the six industries discussed above and present the results in Table II, Panel B for the top three industries among new-list firms and Panel C for the top three industries among pre-1970 firms. In all industries except utilities, successive cohorts display increasing intangible intensity but decreasing material intensity.[9] For example, the average R&D expenditures for successive business services industry cohorts are 0.011, 0.018, 0.075, 0.101, and 0.090, and their market-to-book ratios are 1.512, 1.633, 2.733, 3.380, and 3.166. In contrast, their COGS intensity measures decline at 0.706, 0.686, 0.555, 0.440, and 0.424.[10] These results show that the average intangible intensity of listed firms would increase even if the industry composition of the listed population were unchanged. The results are also consistent with the idea that new firms compete against their established industry counterparts by adopting more intangible intensive production technologies ((Shapiro and Varian 1998; Payne and Frow 2005; Brickley and Zimmerman 2010; Baumol and Schramm 2010).

Panels B and C of Table II also show that the summary financial measures and product-market characteristics change monotonically across listing cohorts within industries. For

[9] The stability of the utility industry's characteristics may be due to the effects of regulation.
[10] We find few significant differences between 1990s and 2000s cohort, a point we do not repeat for brevity.

example, Panel B shows that successive business services industry cohorts have decreasing profitability of 0.043, 0.037, −0.061, −0.139, and −0.154; increasing idiosyncratic volatility of 0.716, 1.022, 1.641, 1.991, and 1.821; and increasing earnings volatility of 0.033, 0.050, 0.125, 0.159, and 0.142. Successive cohorts also display increasing instability and competitiveness in product markets, as evident from the increasing special items of 0.006, 0.005, 0.021, 0.054, and 0.038; increasing product-launch years of 3.57%, 4.27%, 16.38%, 22.66%, and 23.82%; and decreasing Herfirndahl indices of 0.219, 0.201, 0.167, 0.091, and 0.086.

C. Industry Correlation Tests

Panel D of Table II presents the Pearson and Spearman-rank correlations among the pooled average characteristics of the 43 Fama and French industries. This panel shows that intangible intensity (measured by R&D, market-to-book ratio, and inversely by COGS intensity) is negatively associated with profitability but positively associated with the two measures of risk (earnings volatility and idiosyncratic volatility). Furthermore, intangible intensity is positively associated with uncertainty in product markets (measured by special items and product-launch growth threshold and inversely by Herfindahl index). In addition, product-market uncertainty is positively associated with firm risk.

The results support the principal ideas underlying this study, that each cohort uses more intangible-intensive production techniques and faces higher product-market competition than preceding cohorts, and that these underlying operating characteristics are positively related to firm risk. Furthermore, these changes occur both within and across industries, so our results are essentially unchanged when we focus on a given industry. Thus, we contribute to the literature by documenting a fundamental reason for the increasing right-skewness in growth and the

increasing left-skewness in profits of successive cohorts documented by Fama and French (2004) and Ritter and Welch (2002).[11]

IV. Tests of Hypotheses

A. Hypothesis 1

Similar to the tests on changes in successive cohorts' financial characteristics described in Subsection A of Section III, we estimate the pooled averages of each intangible-intensity measure by cohort-year. Figure 3 plots the R&D expenditures for each cohort by cohort-year. We find that each new cohort spends higher amounts on R&D. Even when firms temporarily change their R&D expenditures in response to macroeconomic condition, the lines across cohorts do not intersect. We find similar patterns in other measures of intangible intensity (Figures not presented for brevity).

[Insert Figure 3 near here]

We formally test differences between successive cohorts in Panel A of Table III. Consistent with Hypothesis 2, the successive cohorts show increasing R&D expenditures of 0.014, 0.021, 0.055, 0.075, and 0.104; increasing market-to-book ratios of 1.405, 1.542, 2.290, 2.604, and 2.991; and decreasing COGS intensities of 72.47%, 68.87%, 60.26%, 58.34%, and 51.46%.

[Insert Table III near here]

The cohort averages might not be comparable across cohorts because they are calculated over different periods and could therefore simply represent overall trends. For example, the

[11] Prior studies support the view that intangible intensity is associated with risk (Kothari et al. 2002; Comin and Philippon 2005; Demers and Joos 2007; Bartram, Brown, and Stulz (2012).). The lower profitability of intangible-intensive firms likely reflects the immediate expensing of investment outlays required under US GAAP. Intangible-intensive firms typically have high fixed costs but low marginal costs (Romer 1986), so changes in sales volume can have large effects on profits.

cohort average for the 2000s firms is calculated using only ten observations from 2000 to 2009 while the cohort average for the pre-1970 firms is calculated using 40 observations from 1970 to 2009. Thus, the pre-1970 firms' average includes the 30 earliest annual observations that are characterized by the lowest intangible usage. To test for differences between cohorts after controlling for overall time trends, we estimate the following regression using 140 cohort-year averages, similar to Brown and Kapadia (2007, p. 374) and Srivastava (2014, p. 206):

$$Characteristic_{Cohort,Year} = \beta_1 + \beta_2 \times FiscalYear + \gamma_1 \times DummyListYear1970\_79 + \gamma_2 \times DummyListYear1980\_89 + \gamma_3 \times DummyListYear1990\_99 + \gamma_4 \times DummyListYear2000\_09 + \varepsilon_{Cohort,year}. \quad (4)$$

The *FiscalYear* variable controls for the secular time trend. The variables *DummyListYear1970_79*, *DummyListYear1980_89*, *Dummy ListYear1990_99*, and *DummyListYear2000_09* take the value of one for the cohort-year observations of the 1970s, 1980s, 1990s, and 2000s cohort, respectively, and zero otherwise. Because we do not include a dummy variable for the pre-1970 firm observations, they form the base case. Hence, the coefficients on the dummy variables represent the differences between the average risk of new-list cohorts and pre-1970 firms after controlling for overall time trends.

The results, reported in Panel B of Table III, show that when *R&D* and *Market-to-Book* ratio are the dependent variables, the coefficients on all of the cohort dummies are positive and significant. Thus, all of the new cohorts show higher intangible intensity than pre-1970 firms. Furthermore, a positive and significant coefficient on *List1970_79* (γ_1) implies that the 1970s firms show higher intangible intensity than the pre-1970 firms. *F*-tests on the differences between the regression coefficients of the other successive cohorts (that is γ_1 versus γ_2, γ_2 versus γ_3, and γ_3 versus γ_4) suggest that each new cohort exhibits higher intangible intensity than its

predecessor. We find the opposite results for COGS, indicating that new cohorts exhibit decreasing material intensity, as we expect.

B. Hypothesis 2

We report summary data for product market characteristics in Panel A of Table IV, and find that the successive cohorts display increasing special items (× 100) of 0.620, 0.562, 1.358, 2.590, and 3.030; increasing product-launch years of 10.27%, 11.04%, 18.38%, 23.99%, and 29.21%; and decreasing Herfindahl indices of 0.156, 0.166, 0.144, 0.127, and 0.106. Furthermore, successive cohorts are characterized by increasing product market fluidity of 5.45, 5.29, 6.64, 7.63, and 9.06 (results not reported). These results are consistent with Hypothesis 3 and indicate that successive cohorts have increasingly similar products and face product markets characterized by higher competition and rivalry.

[Insert Table IV near here]

We also estimate equation (4) for product market characteristics. The results, presented in Panel B of Table IV, show that the differences between the product-launch years and Herfindahl indices of the new cohorts versus the preceding cohort remain statistically significant after we control for the overall time trends. However, we find mixed results for the special items. Only two cohorts (1980s and 1990s) have significantly higher special items than their predecessors, though the 1980s, 1990s, and 2000s cohorts have higher special items than pre-1970 firms.

Overall, our results are consistent with Hypothesis 1 and Hypothesis 2, and suggest that firms in successive cohorts have distinct business strategies as measured by their production technologies and product markets characteristics.

C. Hypothesis 3

We examine whether the distinct operating characteristics of successive cohorts are sufficient to explain the cohort-risk phenomenon. We first establish that the successive cohorts show increasing risk even after we control for the overall time trends by estimating the two regressions

$$Risk_{Cohort,year} = \beta_1 + \beta_2 \times Year \ + \varepsilon_{Cohort,year}. \quad (5)$$

and

$$Risk_{Cohort,year} = \beta_1 + \beta_2 \times Year + \gamma_2 \times DummyListYear1970\_79 \ + \gamma_3 \times DummyListYear1980\_89 + \gamma_4 \times DummyListYear1990\_99 \ + \gamma_5 \times DummyListYear2000\_09 + \varepsilon_{Cohort,year}. \quad (6)$$

We present results for models with idiosyncratic volatility and earnings volatility as dependent variables in Panels A and B of Table V, with results for equations (5) and (6) presented under the headings "No controls" and "Control for cohorts," respectively. We observe a large increase in adjusted *R*-squared from equation (5) to (6); that is, after including the cohort dummies. More importantly, the *F*-tests on the differences in coefficients on cohort dummies in equation (6) show that each cohort has significantly higher risks than its predecessor even after we control for time trends.[12] This is consistent with Brown and Kapadia (2007).

[Insert Table V near here]

We next include proxies for both intangible and material intensity as well as cohort dummies in the model

$$Risk_{Cohort,year} = \beta_1 + \beta_2 \times Year$$

[12] The only exception is that the idiosyncratic risks of the 1990s and 2000s cohorts are not significantly different.

$$+ \beta_3 \times R\&D_{Cohort,year} + \beta_4 \times COGS\text{-}Intensity_{Cohort,year}$$

$$+ \gamma_2 \times DummyListYear1970\_79 + \gamma_3 \times DummyListYear1980\_89$$

$$+ \gamma_4 \times DummyListYear1990\_99 + \gamma_5 \times DummyListYear2000\_09$$

$$+ \varepsilon_{Cohort,year}. \quad (7)$$

We present the results of equation (7) in Panels A and B of Table V under the heading "Control for intangible intensity and cohorts." The coefficients on *R&D* and *COGS-Intensity* remain significantly positive and negative, respectively. More important, the coefficients on cohort dummies are much smaller than those in equation (6). *F*-tests on the differential coefficients on successive cohort dummies are no longer statistically significant, indicating that the cohort-risk phenomenon is no longer evident once we control for successive cohorts' production technology. This result supports our hypothesis that the increasing risks of new cohorts are related to increases in their intangible intensity.

Finally, we estimate the following equation by including the proxies for product-market uncertainty:

$$Risk_{Cohort,year} = \beta_1 + \beta_2 \times Year$$

$$+ \beta_3 \times ProductLaunchYear_{Cohort,year} + \beta_4 \times SpecialItems_{Cohort,year}$$

$$+ \gamma_2 \times DummyListYear1970\_79 + \gamma_3 \times DummyListYear1980\_89$$

$$+ \gamma_4 \times DummyListYear1990\_99 + \gamma_5 \times DummyListYear2000\_09$$

$$+ \varepsilon_{Cohort,year}. \quad (8)$$

The results are presented in Panels A and B of Table V under the heading "Control for product-market uncertainty and cohorts." The coefficients on cohort dummies are again much smaller than those in equation (6). However, the differences in cohort dummies remain significant in some cases. Thus, we find less convincing results for the hypothesis that the

increasing product-market uncertainty across cohorts is a principal factor behind their increasing riskiness. We conclude, however, that the distinct intangible intensities and product-market characteristics of successive cohorts are together sufficient to account for essentially the cohort-risk phenomenon.

A. Hypothesis 4

Risk differences across cohorts could arise because an increasing number of firms in each cohort list their shares early in their life cycles (Jovanovic and Rousseau 2001). If so, the surviving new-list firms' operating uncertainty and risk should decline over time as they mature, and should converge on the previously-listed firms' measures. We examine this proposition by first estimating the survival rates for successive cohorts. Figure 4 shows that survival rates, represented by inverse of slopes of downward curves, for successive cohorts are lower and remain distinct. The survival rates over the five years from the last year a firm enters its cohort are 77% for the 1970s cohort, 67% for the 1980s cohort, and 53% for the 1990s cohort (results not tabulated). By comparison, the five-year survival rate of pre-1970 firms is 92%.

We assess the distinctiveness of cohorts' risks by measuring their half-life (the number of years it takes for the sample to be halved) at the 50% and 25% survival levels. If survival times are cohort-specific then the successive half-life measures should be similar within a cohort but distinct across cohorts. We also expect half-lives to decline with each successive cohort. Our findings fit this pattern. The first and second half-life measures for pre-1970 firms are 18 and 15 years, respectively. The corresponding half-lives for the remaining cohorts are 10.5 and 10 years for the 1970s cohort, 8.5 and 7.5 years for the 1980s cohort, and 5.5 and 7 or so years for the 1990s cohort (results not tabulated). Thus cohorts seem to retain their distinct survival

characteristics even after several decades, with little sign of convergence. This pattern is inconsistent with the life-cycle hypothesis.

[Insert Figure 4 near here]

We estimate the difference between the average characteristics of each new-list cohort and pre-1970 for each year. These differences should decline to zero over time if cohort-risk phenomenon is only due to early-listing of new-list firm then. Figures 5 and 6 plot difference in idiosyncratic volatility and R&D for each cohort over time. These figures show no consistent evidence of convergence in risk or operating characteristics of new-list firm on those of pre-1970 firms over time. On the contrary, it appears that the differences in risk and R&D move in similar direction over time, which is consistent with the business-strategy explanation.

We more formally test for over-time convergence in operating and risk characteristics of new-list firms with pre-1970 firms by estimating the regression

$$DifferenceOfCharacteristicBetweenCohortAndPre\text{-}1970Firms_{year} = \beta_1 + \beta_2 \times SubsequentYear + \varepsilon_{Year}, \quad (9)$$

where the dependent variable is the difference between the average characteristics of a new-list cohort and pre-1970 firms for each year. *SubsequentYear* is a year indicator that begins at zero and increases by one with each passing year. If the differences between new-list and pre-1970 firms narrow over time then the coefficient on *SubsequentYear* (β_2), should have a sign opposite to that of the average difference in that characteristic.

We estimate equation (9) using 100 observations, comprised of 40 annual differences for the 1970s cohort, 30 annual differences for the 1970s cohort, 20 annual differences for the 1990s cohorts, and ten annual differences for the 2000s cohorts, from pre-1970 firms. Table VI presents the results of these regressions for each of the three financial characteristics (profitability,

idiosyncratic volatility, and earnings volatility), intangible-intensity measures (R&D, market-to-book ratio, and COGS intensity), and product-market characteristics (special items, product-launch years, and Herfindahl index). We find little evidence that cohort characteristics converge on those of pre-1970 firms over time. Only one variable, profitability, shows convergence. Six of the nine variables show divergence. These results are inconsistent with the idea that the new-list phenomenon arises because firms list their shares a few years sooner than they would have previously. Accordingly, we reject the hypothesis that the early stage listing is the principal cause of the cohort-risk effect.

[Insert Table VI near here]

V. Concluding Remarks

Prior studies find that pre-1970 firms' risk levels have remained stable over time, but the risk level of each new cohort of listed firms is higher than its predecessors'. We find that risk differences across successive cohorts persist. We examine two potential explanations for this cohort-risk phenomenon, both focused on the changes in the nature and the characteristics of public firms. The first is that firms from new cohorts introduce innovations in their business strategies that are associated with higher risks, but that the previous cohorts do not adopt these innovations. The second is that new cohorts are increasingly comprised of firms with less-mature operations. We find significant support for the first explanation but no support for the second explanation. Specifically, firms from successive cohorts enter more knowledge-intensive industries. Even within the same industries, successive cohorts use higher levels of intangible inputs. Furthermore, new cohorts operate in product markets characterized by higher uncertainty and competition. The cohort-risk effect is significantly attenuated once we account for new cohorts' distinctive operating characteristics. Thus, we conclude that the sustained increase in the

riskiness of the new cohorts is mainly due to the persistent differences in their operating characteristics. This phenomenon also explains the increasing right-skewness in growth and left-skewness in profits of new cohorts documented in the literature.

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Appendix

Definitions of Variables and Firm Categories

The firm population consists of all non-finance firms that in a sample formation year have daily-stock price data from the current year (from CRSP); assets data from the previous year; and assets, earnings, and revenues data (from Compustat) from the current year and the next three years. All variables are winsorized at the 1st and 99th percentiles. In time series tests, variables are calculated on a firm-year basis (proportions and volatilities) and then averaged by cohort year. In cross-sectional tests, industry values are calculated by averaging variables (firm-year-based variables) by industry.

A. From CRSP

Firm-Specific Volatility (IV) = We first estimate the variance of residuals from the following equation, estimated on a firm-month basis:

$$R_{d,m,y,i} = \alpha_{i,m,y} + \beta_{1,i,m,y} \times (Rm_{d,m,y} - Rf_{d,m,y}) + \beta_{2,i,m,y} \times SMB_{d,m,y} + \beta_{3,i,m,y} \times HML_{d,m,y} + \varepsilon_{d,m,y,i} \quad \text{(A1)}$$

where R = daily stock return (CRSP RET);

Rm = daily return on value-weighted market portfolio (CRSP VWRETD);

Rf = Risk-free rate (CRSP RF), *SMB*, *HML* = daily Fama and French factors, d = day on which the stock was traded, m = month, y = fiscal year, and i = each firm.

We calculate idiosyncratic volatility using the residuals from equation (A1) for each firm month as:

$$IV_{m,y,i} = Variance\ (\varepsilon_{d,m,y,i}). \quad \text{(A2)}$$

Then, we calculate *Firm-Specific Volatility* for each firm year by averaging the 12 variance estimates from that year.

B. From Compustat Annual

Total Assets = Total assets (AT).

Revenues = Revenue (SALE) scaled by average *Total Assets*.

Earnings/Profitability = Income before extraordinary items (IB), scaled by average *Total Assets*.

Total Expense = SALE − IB

COGS intensity = Cost of Goods Sold (XSGA) scaled by *Total Expense*, represents material intensity

R&D = R&D expenditures (XRD) scaled by average *Total Assets*.

Special Items = −1 × SPI scaled by average total assets.

Market Value of Equity = Market value of equity [Price (PRCC_F) × Number of shares outstanding (CSHO)].

Market-to-Book Ratio = Market to book ratio [*Market Value of Equity*) +Total Liabilities [*Total Assets* – shareholder equity {CEQ})]/ *Total Assets*.

Operating Profit Margin (OPM) = Operating Profits after Depreciation (OIADP)/Revenue (SALE).

Earnings Volatility = Standard deviation of earnings for the rolling four- year windows: years y through y+3.

Herfindahl Index (*H-Index*) = $H - Index_{j,t} = \sum S_{i,j,y}^2$, where S_{ijy} is the revenue share of firm i in industry j in year y. We define industry by three-digit SIC code, consistent with Hou and Robinson (2006).

Product-Market Fluidity = Data on a firm-year basis for years 1997 to 2008 are obtained from the coauthors of Hoberg, Phillips, and Prabhala (2014).

Appendix (continued)
Definitions of variables

C. From Compustat Quarterly		
Product launch year	=	We classify a year in which a firm shows seasonally-adjusted quarterly growth in revenues (SALESQ) at the top decile of its industry (Fama–French 48-industry classification) as a successful product launch. The threshold of growth in an industry at which its firm qualifies for Product launch year is called *product launch growth threshold.*
D. Firm Category		
Industry	=	Fama–French 48-industry classification, excluding industry numbers 44–47 representing finance firms, and industry number 48 representing "almost nothing," leaving 43 industries.
Listing year	=	First year for which the firm has valid data.
Pre-1970 firms	=	Firms whose listing year is before 1970.
Cohort of firms	=	Firms whose listing years fall in the same decade are categorized in one cohort. *DummyList1970_79*, *DummyList1980_89*, *Dummy List1990_99*, and *DummyList2000_09* take the value of one for the cohort-year observations of the 1970s, 1980s, 1990s, and the 2000s cohorts, respectively, and zero otherwise.
New-list firms	=	Firms that are not pre-1970 firms.

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s. All financial characteristics are calculated on a cohort-year basis as described in the Appendix. Figures 1, 2, and 3 plot the idiosyncratic volatility, the earnings volatility, and R&D expenditures, respectively, for each year by cohort. Figure 4 plots the proportion of firms in a listing cohort that survive in a given year from the last year of its formation decade. The steeper the slope of the curve the lower the survival rate. Figures 5 and 6 plot the difference in idiosyncratic volatility and R&D expenditures, respectively, for each cohort year and pre-1970 firms for each year.

Figure 1. Idiosyncratic volatility

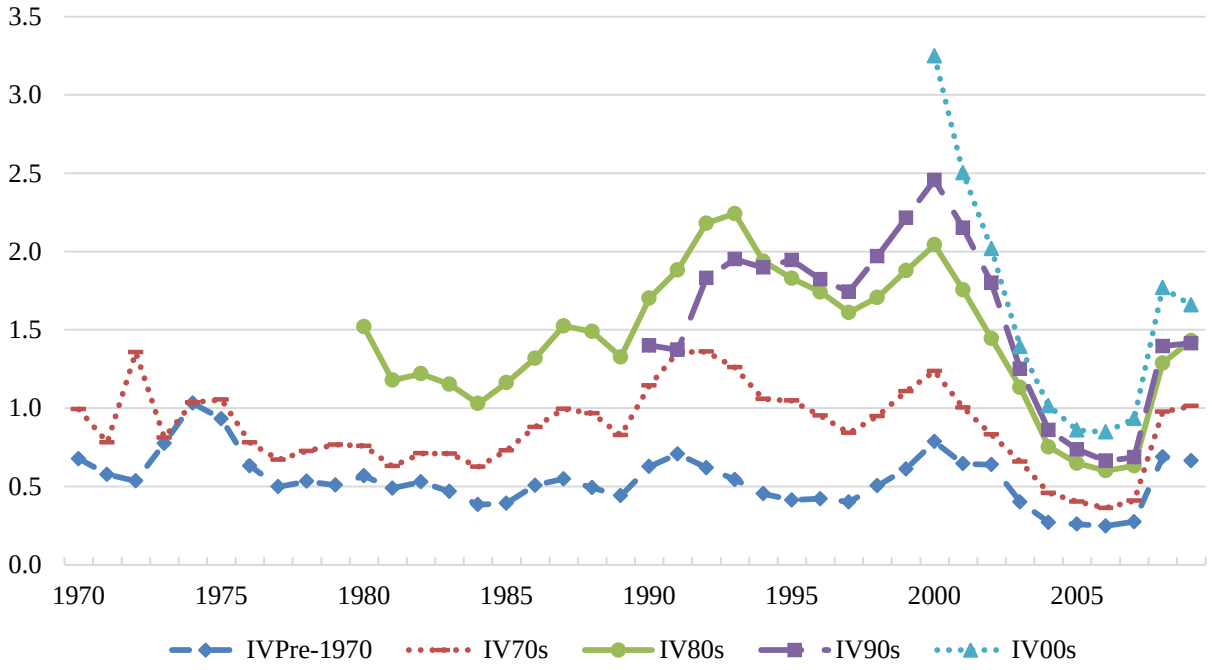

Figure 2. Earnings volatility

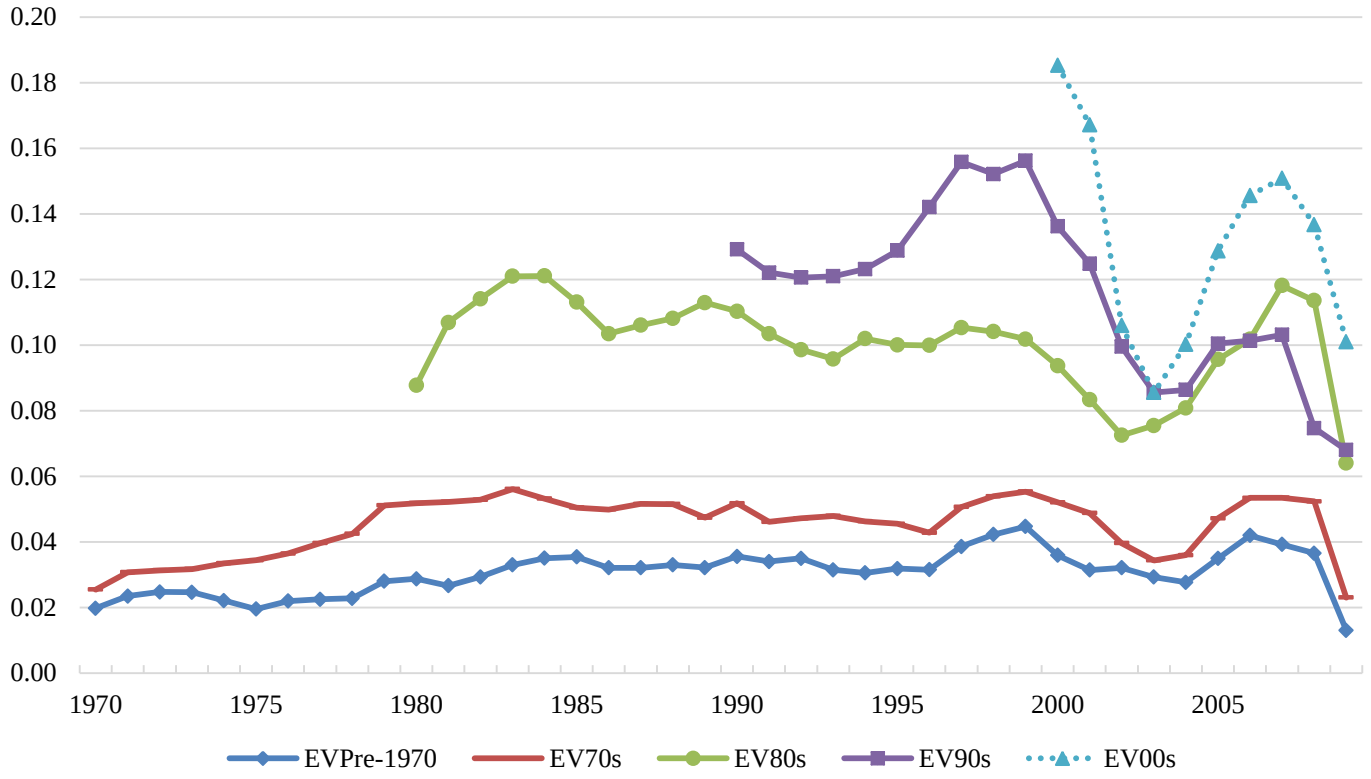

Figure. 3 Research & development

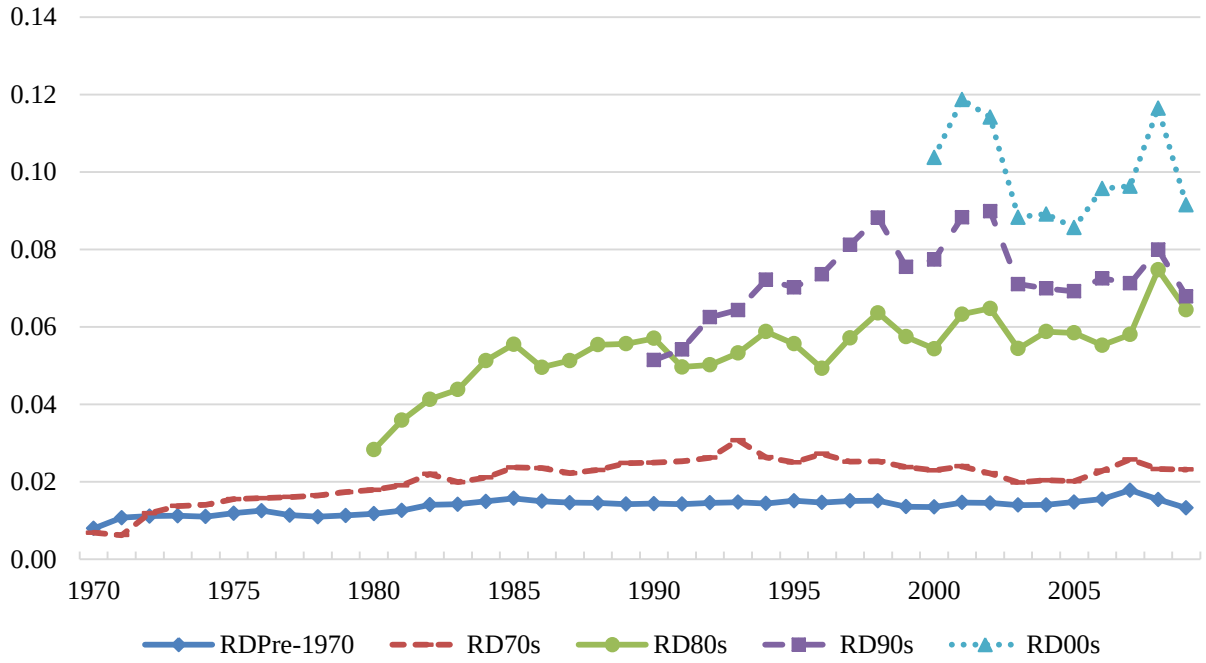

Figure 4. Survival rates of successive cohorts measured from the last year of their formation decade

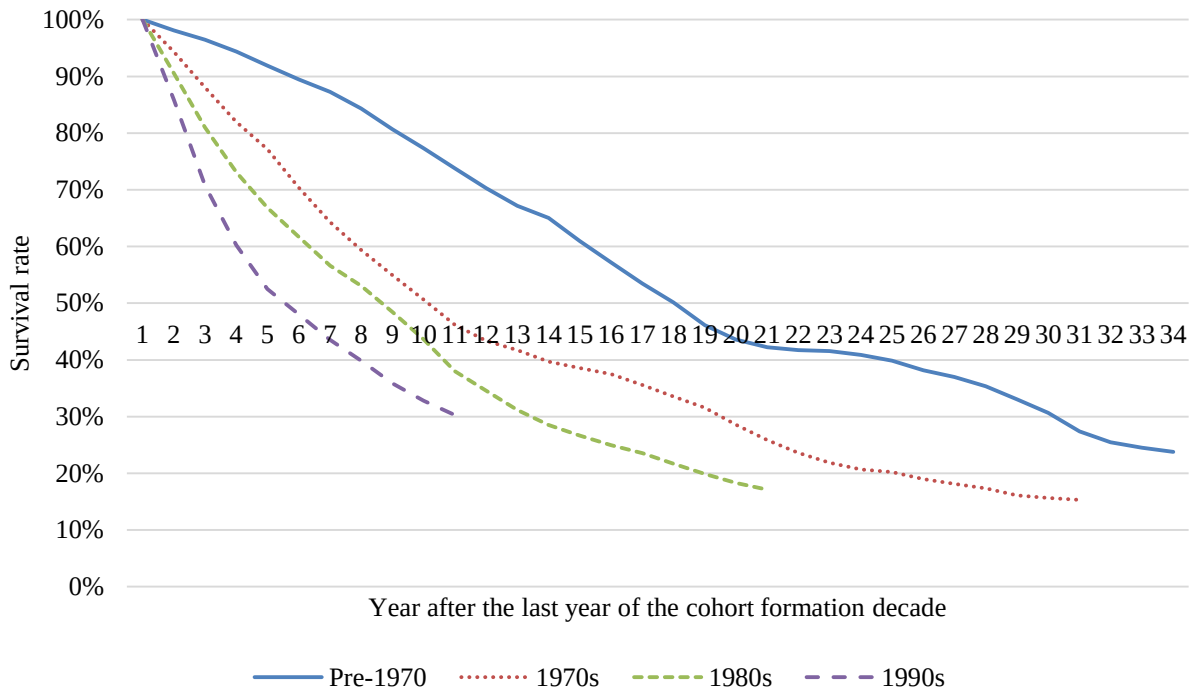

Figure 5. Difference in idiosyncratic volatility of each cohort from pre-1970 firms

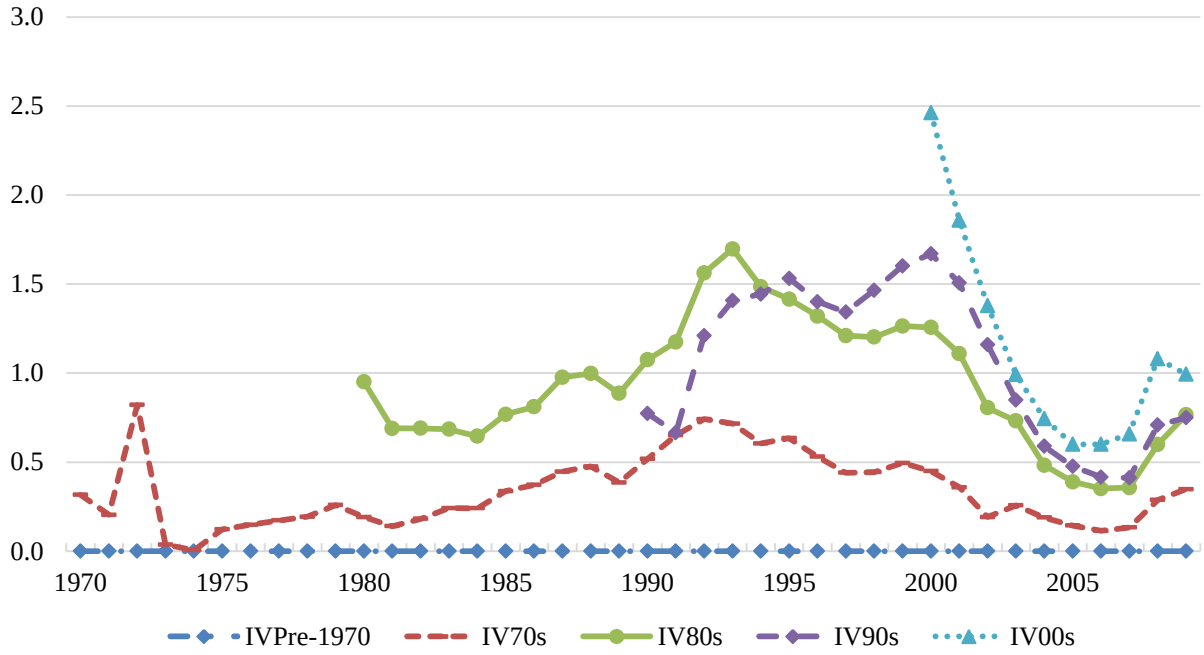

Figure 6. Difference in research & development expenditures of each cohort from pre-1970 firms

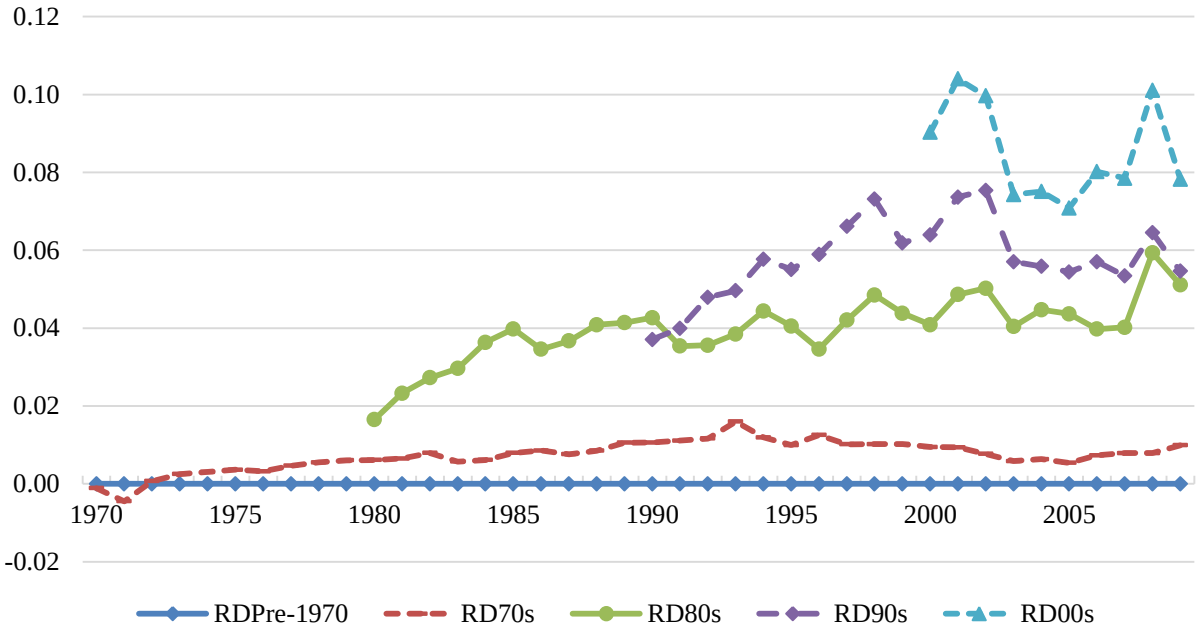

Table I

Financial characteristics of successive cohorts of listed firms and inter-cohort differences

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s.

Panel A: Annual observations

Fiscal Year	Total number of firms	Pre-1970 firms	1970s cohort	1980s cohort	1990s cohort	2000s cohort
1970	1,967	1,851	116			
1971	2,077	1,816	261			
1972	2,918	1,786	1,132			
1973	3,431	1,747	1,684			
1974	3,665	1,701	1,964			
1975	3,607	1,656	1,951			
1976	3,600	1,615	1,985			
1977	3,544	1,561	1,983			
1978	3,538	1,493	2,045			
1979	3,594	1,431	2,163			
1980	3,695	1,366	2,040	289		
1981	3,979	1,301	1,905	773		
1982	4,091	1,243	1,773	1,075		
1983	4,508	1,204	1,669	1,635		
1984	4,667	1,128	1,522	2,017		
1985	4,692	1,059	1,391	2,242		
1986	4,878	990	1,285	2,603		
1987	5,098	928	1,188	2,982		
1988	4,945	854	1,095	2,996		
1989	4,802	807	999	2,996		
1990	4,736	782	938	2,712	304	
1991	4,834	772	903	2,427	732	
1992	5,126	769	859	2,190	1,308	
1993	5,615	757	834	2,003	2,021	
1994	6,027	738	811	1,849	2,629	
1995	6,236	706	770	1,697	3,063	
1996	6,875	685	726	1,590	3,874	
1997	7,271	654	683	1,451	4,483	
1998	6,745	611	618	1,308	4,208	
1999	6,445	568	560	1,138	4,179	
2000	6,484	507	510	1,035	3,587	845
2001	5,721	471	473	934	2,957	886
2002	5,174	454	447	854	2,517	902
2003	4,818	440	437	799	2,195	947
2004	4,820	431	411	747	2,008	1,223
2005	4,707	409	392	705	1,818	1,383
2006	4,696	400	375	650	1,665	1,606
2007	4,702	374	348	595	1,499	1,886
2008	4,443	359	338	549	1,371	1,826
2009	4,268	347	331	512	1,265	1,813
Total	187,039	38,771	41,915	45,353	47,683	13,317

Table I continued

Financial characteristics of successive cohorts of listed firms and inter-cohort differences

All financial characteristics are calculated on a cohort-year basis as described in the Appendix. We use 40 annual differences between pre-1970 firms and 1970s cohort, 30 annual differences between 1970s and 1980s cohorts, 20 annual differences between 1980s and 1990s cohorts, and ten annual differences between 1990s and 2000s cohorts to estimate the significance of each difference. *,**,*** indicate significance at *p*-levels of 0.10, 0.05, and 0.01, respectively.

Panel B: Financial characteristics by listing cohorts

	Profitability		IV× 1,000		Earnings volatility	
	Average	Difference between cohorts	Average	Difference between cohorts	Average	Difference between cohorts
Pre-1970 Firms	0.044		0.542		0.031	
		−0.006*		0.339***		0.015***
1970s cohort	0.037		0.881		0.046	
		−0.085***		0.557***		0.056***
1980s cohort	−0.048		1.438		0.101	
		−0.040***		0.122***		0.018***
1990s cohort	−0.087		1.560		0.119	
		−0.076***		0.041		0.016
2000s cohort	−0.163		1.601		0.134	

Table II

Industry characteristics of pre-1970 firms and the new-list firm categories

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s. The firms are also classified by the Fama and French 48-industry method. Four industries representing the finance firms and one "almost nothing" category are excluded. All variables are defined in the Appendix

Panel A: Top three industries of the pre-1970 and new-list firm categories

	Pre-1970 firms				New-list firms			
		Proportion of observations	R&D	COGS intensity		Proportion of observations	R&D	COGS intensity
Rank	Industry				Industry			
1	Utility	10.43%	0.000	0.785	Business services	11.44%	0.081	0.504
2	Retail	6.46%	0.000	0.713	Electronic equipment	6.29%	0.100	0.584
3	Machinery	5.10%	0.022	0.725	Pharmaceutical products	5.53%	0.293	0.592
Total proportion		23.26%				21.99%		

Panel B: Average characteristics of the top three new-list industries

Business services	Pre-1970 Firms	1970s Cohort	1980s Cohort	1990s Cohort	2000s Cohort
Profitability	0.043	0.037	−0.061	−0.139	−0.154
IV× 1,000	0.716	1.022	1.641	1.991	1.821
Earnings volatility	0.033	0.050	0.125	0.159	0.142
R&D	0.011	0.018	0.075	0.101	0.090
Market-to-book ratio	1.512	1.633	2.733	3.380	3.166
COGS intensity	0.706	0.686	0.555	0.440	0.424
Special items	0.006	0.005	0.021	0.054	0.038
Product-launch years	3.57%	4.27%	16.38%	22.66%	23.82%
Herfindahl index	0.219	0.201	0.167	0.091	0.086
Electronic equipment					
Profitability	0.040	0.030	−0.043	−0.068	−0.113
IV× 1,000	0.875	1.099	1.710	1.714	1.764
Earnings volatility	0.045	0.068	0.113	0.140	0.129
R&D	0.041	0.065	0.094	0.124	0.132
Market-to-book ratio	1.376	1.723	2.140	3.162	2.749
COGS intensity	0.731	0.645	0.585	0.556	0.518
Product-launch years	0.006	0.008	0.017	0.033	0.047
OPM volatility	12.78%	11.32%	22.94%	24.24%	32.65%
Herfindahl index	0.120	0.094	0.089	0.077	0.062
Pharmaceutical products					
Profitability	0.100	0.040	-0.245	-0.385	-0.539
IV× 1,000	0.349	1.155	1.513	1.968	1.720
Earnings volatility	0.029	0.066	0.178	0.220	0.272
R&D	0.068	0.066	0.226	0.332	0.397
Market-to-book ratio	2.739	2.963	4.395	4.496	4.208
COGS intensity	0.462	0.526	0.547	0.653	0.555
Special items	0.012	0.008	0.024	0.031	0.044
Product-launch years	2.41%	2.00%	18.32%	25.42%	24.14%
Herfindahl index	0.055	0.055	0.049	0.049	0.054

Table II continued

Industry characteristics of pre-1970 firms and the new-list firm categories

Panel C: Average characteristics of the top three pre-1970 industries

Utility	Pre-1970 Firms	1970s Cohort	1980s Cohort	1990s Cohort	2000s Cohort
Profitability	0.040	0.037	0.019	0.024	0.035
IV× 1,000	0.152	0.268	0.551	0.723	0.572
Earnings volatility	0.008	0.010	0.022	0.037	0.032
R&D	0.000	0.000	0.000	0.000	0.000
Market-to-book ratio	1.099	1.129	1.247	1.266	1.778
COGS intensity	0.785	0.814	0.797	0.694	0.774
Special items	0.001	0.001	0.004	0.003	0.006
Product-launch years	18.30%	20.05%	32.24%	41.67%	51.83%
Herfindahl index	0.024	0.055	0.052	0.108	0.127
Retail					
Profitability	0.047	0.049	0.006	0.015	0.020
IV× 1,000	0.638	0.696	1.382	1.437	1.279
Earnings volatility	0.026	0.033	0.061	0.055	0.064
R&D	0.000	0.001	0.003	0.003	0.010
Market-to-book ratio	1.287	1.321	1.879	2.000	2.531
COGS intensity	0.713	0.698	0.671	0.665	0.668
Special items	0.005	0.003	0.010	0.015	0.017
Product failure	14.39%	12.91%	22.61%	20.47%	21.72%
Herfindahl index	0.167	0.170	0.162	0.170	0.149
Machinery					
Profitability	0.041	0.050	−0.034	−0.019	−0.110
IV× 1,000	0.652	0.771	1.549	1.488	1.262
Earnings volatility	0.033	0.039	0.086	0.096	0.095
R&D	0.022	0.026	0.059	0.059	0.052
Market-to-book ratio	1.214	1.396	2.132	2.182	2.668
COGS intensity	0.725	0.687	0.611	0.635	0.623
Special items	0.005	0.004	0.011	0.019	0.031
Product-launch years	11.10%	11.57%	27.88%	32.16%	27.61%
Herfindahl index	0.142	0.135	0.140	0.143	0.177

Table II continued

Industry characteristics of pre-1970 firms and the new-list firm categories

Panel D: Correlation among the characteristics of industries (*N*=43 industries)

Spearman rank correlation		Pearson correlation								
		Profit-ability	IV	Earnings volatility	R&D	Market-to-book ratio	COGS	Special items	Product-launch growth threshold	Herfindahl index
	Profitability		−0.700 (<0.01)	−0.917 (<0.01)	−0.862 (<0.01)	−0.855 (<0.01)	0.548 (<0.01)	−0.556 (<0.01)	-0.865 (<0.01)	0.399 (0.01)
	IV	−0.855 (<0.01)		0.816 (<0.01)	0.481 (<0.01)	0.592 (<0.01)	−0.526 (<0.01)	0.682 (<0.01)	0.772 (<0.01)	−0.242 (0.11)
	Earnings volatility	−0.862 (<0.01)	0.820 (<0.01)		0.762 (<0.01)	0.869 (<0.01)	−0.650 (<0.01)	0.730 (<0.01)	0.864 (<0.01)	−0.313 (0.04)
	R&D	−0.453 0.002	0.481 (<0.01)	0.762 (<0.01)		0.792 (<0.01)	−0.430 (<0.01)	0.508 (<0.01)	0.629 (<0.01)	−0.283 (0.07)
	Market-to-book ratio	−0.627 (<0.01)	0.547 (<0.01)	0.710 (<0.01)	0.410 (<0.01)	1.000	−0.855 (<0.01)	0.679 (<0.01)	0.715 (<0.01)	−0.227 (0.14)
	COGS	0.582 (<0.01)	−0.517 (<0.01)	−0.590 (<0.01)	−0.430 (<0.01)	−0.747 (<0.01)		−0.581 (<0.01)	-0.503 (<0.01)	0.300 (0.05)
	Special items	−0.623 (<0.01)	0.578 (<0.01)	0.702 (<0.01)	0.508 (<0.01)	0.674 (<0.01)	−0.564 (<0.01)		0.616 (<0.01)	−0.263 (0.08)
	Product- launch growth threshold	-0.854 (<0.01)	0.858 (<0.01)	0.861 (<0.01)	0.275 (0.07)	0.514 (<0.01)	-0.433 (<0.01)	0.584 (<0.01)		-0.260 (0.09)
	Herfindahl index	0.348 (0.02)	−0.289 (0.06)	−0.318 (0.03)	−0.283 (0.06)	−0.246 (0.11)	0.289 (0.06)	−0.222 (0.15)	-0.306 (0.04)	

Table III

Average intangible intensity of successive cohorts of listed firms and inter-cohort differences

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s. *Characteristic* refers to one of the three measures of intangible intensity, R&D, Market-to-book ratio, or COGS intensity, as defined in the Appendix. It is calculated on a cohort-year basis. We use 40 annual differences between pre-1970 firms and 1970s cohort, 30 annual differences between 1970s and 1980s cohorts, 20 annual differences between 1980s and 1990s cohorts, and ten annual differences between 1990s and 2000s cohorts to estimate the significance of differences across cohorts. *,**,*** indicate significance at *p*-levels of 0.10, 0.05, and 0.01, respectively.

Panel A: Intangible intensity measures

	R&D		Market-to-book ratio		COGS intensity	
	Average	Difference between cohorts	Average	Difference between cohorts	Average	Difference between cohorts
Pre-1970 firms	0.014	0.007***	1.405	0.138**	72.47%	−3.60%***
1970s cohort	0.021	0.034***	1.542	0.747***	68.87%	−8.61%***
1980s cohort	0.055	0.020***	2.290	0.314***	60.26%	−1.92%***
1990s cohort	0.075	0.029***	2.604	0.388*	58.34%	−6.89%***
2000s cohort	0.104		2.991		51.46%	

Table III continued

Average intangible intensity of successive cohorts of listed firms and inter-cohort differences

For Panel B, we estimate the regression

$Characteristic_{Cohort,year} = \beta_1 + \beta_2 \times FiscalYear + \gamma_1 \times DummyListYear1970\_79 + \gamma_2 \times DummyListYear1980\_89 + \gamma_3 \times DummyListYear1990\_99 + \gamma_4 \times DummyListYear2000\_09 + \varepsilon_{Cohort,year}$

where dummy variables *DummyListYear1970_79, DummyListYear1980_89, DummyListYear1990_99, and DummyListYear2000_09* take the value of one for the cohort-year observations of the 1970s, 1980s, 1990s, and 2000s cohorts respectively and zero otherwise. Because a dummy variable for the pre-1970-firm observations is not included in the above regression, they form the base case. The regression is estimated by using 140 cohort-year observations, comprised of 40 annual observations for the pre-1970-firm category (1970–2009), 40 annual observations for the 1970s cohort (1970–2009), 30 annual observations for the 1980s cohort (1980–2009), 20 annual observations for the 1990s cohort (1990–2009), and ten annual observations for the 2000s cohort (2000–2009).

Panel B: Differences in intangible intensity across successive cohorts after controlling for time trends

	R&D		Market-to-book ratio		COGS intensity	
	Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
Intercept	−0.599	<0.001	1.662	0.791	1.476	<0.001
Fiscal year×1,000	0.308	<0.001	−0.129	0.967	−0.378	0.008
DummyListYear1970_79	0.007	<0.001	0.139	0.094	−0.036	<0.001
DummyListYear1980_89	0.040	<0.001	0.885	<0.001	−0.120	<0.001
DummyListYear1990_99	0.058	<0.001	1.201	<0.001	−0.138	<0.001
DummyListYear2000_09	0.085	<0.001	1.586	<0.001	−0.204	<0.001
N		140		140		140
F-value		508.531		34.95		459.54
Probability		<0.001		<0.001		<0.001
Adjusted *R*-squared		94.81%		54.98%		94.28%
F-Tests						
Average pre-1970 firms < 1970s cohort ($0 < \gamma_1$)		<0.001		0.094		<0.001
Average 1970s cohort < 1980s cohort ($\gamma_1 < \gamma_2$)		<0.001		<0.001		<0.001
Average 1980s cohort < 1990s cohort ($\gamma_2 < \gamma_3$)		<0.001		0.003		<0.001
Average 1990s cohort < 2000s cohort ($\gamma_3 < \gamma_4$)		<0.001		0.007		<0.001

Table IV

Average product-market characteristics of successive cohorts of listed firms and inter-cohort differences

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s. *Characteristic* refers to one of the three measures of product-market uncertainty, Special items, OPM volatility, or Herfindahl index, as defined in the Appendix. It is calculated on a cohort-year basis. We use 40 annual differences between pre-1970 firms and 1970s cohort, 30 annual differences between 1970s and 1980s cohorts, 20 annual differences between 1980s and 1990s cohorts, and ten annual differences between 1990s and 2000s cohorts to estimate the significance of differences across cohorts. *,**,*** indicate significance at *p*-levels of 0.10, 0.05, and 0.01, respectively.

Panel A: Product-market characteristics

	Special items× 100		Product-launch years		Herfindahl index	
	Average	Difference between cohorts	Average	Difference between cohorts	Average	Difference between cohorts
Pre-1970 firms	0.620	−0.058	10.27%	0.78%	0.156	0.010*
1970s cohort	0.562		11.04%		0.166	
1980s cohort	1.358	0.796***	18.38%	7.34%***	0.144	−0.022***
1990s cohort	2.590	1.232***	23.99%	5.61%**	0.127	−0.017***
2000s cohort	3.030	0.440	29.21%	5.22%**	0.106	−0.021***

Table IV continued

Average product-market characteristics of successive cohorts of listed firms and inter-cohort differences

For Panel B, we estimate the regression

$Characteristic_{Cohort,year} = \beta_1 + \beta_2 \times FiscalYear + \gamma_1 \times DummyListYear1970\_79 + \gamma_2 \times DummyListYear1980\_89 + \gamma_3 \times DummyListYear1990\_99 + \gamma_4 \times DummyListYear2000\_09 + \varepsilon_{Cohort,year}$

where dummy variables *DummyListYear1970_79, DummyListYear1980_89, DummyListYear1990_99, and DummyListYear2000_09* take the value of one for the cohort-year observations of the 1970s, 1980s, 1990s, and 2000s cohorts respectively and zero otherwise. Because a dummy variable for the pre-1970-firm observations is not included in the above regression, they form the base case. The regression is estimated by using 140 cohort-year observations, comprised of 40 annual observations for the pre-1970-firm category (1970–2009), 40 annual observations for the 1970s cohort (1970–2009), 30 annual observations for the 1980s cohort (1980–2009), 20 annual observations for the 1990s cohort (1990–2009), and ten annual observations for the 2000s cohort (2000–2009).

Panel B: Differences in product-market uncertainty across successive cohorts after controlling for time trends

	Special items		Product-launch years		Herfindahl index	
	Estimate	*p*-value	Estimate	*p*-value	Estimate	*p*-value
Intercept	−0.643	<0.001	4.149	<0.001	1.319	<0.001
Fiscal year×1,000	0.066	<0.001	-0.002	<0.001	−0.001	<0.001
DummyListYear1970_79	−0.000	0.743	0.008	0.591	0.011	<0.001
DummyListYear1980_89	0.006	0.001	0.091	<0.001	−0.009	0.025
DummyListYear1990_99	0.017	<0.001	0.158	<0.001	−0.022	<0.001
DummyListYear2000_09	0.020	<0.001	0.220	<0.001	−0.041	<0.001
N		140		140		140
F-value		42.31		29.12		35.66
Probability		<0.001		<0.001		<0.001
Adjusted *R*-squared		59.77%		50.28%		55.49%
F-Tests						
Average Pre-1970 firms < 1970s cohort ($0< \gamma_1$)		0.743		0.591		<0.001
Average 1970s cohort < 1980s cohort ($\gamma_1< \gamma_2$)		0.005		0.005		<0.001
Average 1980s cohort < 1990s cohort ($\gamma_2<\gamma_3$)		<0.001		<0.001		0.005
Average 1990s cohort < 2000s cohort ($\gamma_3< \gamma_4$)		0.392		0.014		0.004

Table V

Differences in firm-specific risks across cohorts after controlling for intangible intensity and product-market uncertainty

Pre-1970 firms are listed before 1970; all others are new-list firms. Firms whose listing years fall in the same decade are categorized in one cohort. Consequently, all of the firms are divided into pre-1970 firms or cohorts of the 1970s, 1980s, 1990s, and 2000s. We estimate the regression $Risk_{Cohort,year} = \beta_1 + \beta_2 \times FiscalYear + \sum \beta_s \times OperatingCharacteristic_{Cohort,year} + \gamma_1 \times DummyListYear1970\_79 + \gamma_2 \times DummyListYear1980\_89 + \gamma_3 \times DummyListYear1990\_99 + \gamma_4 \times DummyListYear2000\_09 + \varepsilon_{Cohort,year}$ where *Risk* refers to idiosyncratic volatility in Panel A and earnings volatility in Panel B. It represents the average value of all firms in a listing cohort in that year, and is defined in the Appendix. The dummy variables *DummyListYear1970_79*, *DummyListYear1980_89*, *DummyListYear1990_99*, and *DummyListYear2000_09* take the value of one for the cohort-year observations of the 1970s, 1980s, 1990s, and 2000s cohort, respectively, and zero otherwise. Because a dummy variable for the pre-1970 firm observations is not included in the above regressions, they form the base case. The regressions are estimated by using 140 cohort-year observations: 40 annual observations for the pre-1970 firm category (1970–2009), 40 annual observations for the 1970s cohort (1970–2009), 30 annual observations for the 1980s cohort (1980–2009), 20 annual observations for the 1990s cohort (1990–2009), and ten annual observations for the 2000s cohort (2000–2009).

Panel A: Idiosyncratic volatility

	No controls		*Control for cohorts*		*Control for intangible intensity and cohorts*		*Control for product-market uncertainty and cohorts*	
Intercept	–15.278	0.077	15.652	<0.001	32.823	<0.001	41.216	<0.001
Fiscal year	0.008	0.058	−0.007	<0.001	−0.015	<0.001	-0.020	<0.001
R&D					21.162	<0.001		
COGS					−3.042	0 .076		
Product-launch years							0.961	0.009
Special items							20.758	<0.001
H-index							-8.181	<0.001
DummyListYear1970_79			0.339	0.001	0.073	0.469	0.422	<0.001
DummyListYear1980_89			0.939	<0.001	–0.268	0.301	0.612	<0.001
DummyListYear1990_99			1.094	<0.001	−0.553	0.092	0.376	0.000
DummyListYear2000_09			1.173	<0.001	−1.266	0.009	0.201	0.143
N		140		140		140		140
F-value		3.63		34.99		34.86		59.91
Probability		0.058		<0.001		<0.001		<0.001
Adjusted *R*-squared		1.86%		55.01%		63.03		79.23%
F-Tests								
Average Pre-1970 firms < 1970s cohort				$(0 < \gamma_1)$		0.001		0.469		<0.001
Average 1970s cohort < 1980s cohort				$(\gamma_1 < \gamma_2)$		<0.001		No		<0.001
Average 1980s cohort < 1990s cohort				$(\gamma_2 < \gamma_3)$		0.073		No		No
Average 1990s cohort < 2000s cohort				$(\gamma_3 < \gamma_4)$		0.295		No		No

Table V continued

Differences in firm-specific risks across cohorts after controlling for intangible intensity and product-market uncertainty

Panel B: Earnings volatility

	No controls		*Control for cohorts*		*Control for intangible intensity and cohorts*		*Control for product-market uncertainty and cohorts*	
Intercept	–2.981	<0.001	−0.149	0.559	0.508	0.067	-0.477	0.060
Fiscal year × 1,000	0.015	<0.001	0.091	0.481	−0.141	0.284	0.000	0.052
R&D					0.389	0.033		
COGS					−0.279	<0.001		
Product-launch years							0.133	<0.001
Special items							0.450	0.003
H-index							0.061	0.363
DummyListYear1970_79			0.145	<0.001	0.001	0.679	0.014	<0.001
DummyListYear1980_89			0.070	<0.001	0.021	0.038	0.058	<0.001
DummyListYear1990_99			0.087	<0.001	0.025	0.049	0.061	<0.001
DummyListYear2000_09			0.102	<0.001	0.011	0.562	0.066	<0.001
N		135		135		135		140
F-value		26.46		185.92		161.14		169.90
Probability		<0.001		<0.001		<0.001		<0.001
Adjusted *R*-squared		15.96		87.34%		89.38%		91.90%
F-Tests								
Average Pre-1970 firms < 1970s cohort				$(0< \gamma_1)$				<0.001
Average 1970s cohort < 1980s cohort				$(\gamma_1< \gamma_2)$				<0.001
Average 1980s cohort < 1990s cohort				$(\gamma_2<\gamma_3)$				0.416
Average 1990s cohort < 2000s cohort				$(\gamma_3< \gamma_4)$				0.357

Table VI

Tests of convergence of operating and financial characteristics across successive cohorts of listed firms

The firms are divided into five listing cohorts. The first year in which a firm's data are available in Compustat is the listing year. All firms with a listing year before 1970 are classified as pre-1970 firms. The remaining firms are classified as new-list firms. All of the cohorts listed in a common decade are a cohort of new-list firms. Consequently, all of the firms are divided into pre-1970 firms or a cohort from the 1970s, 1980s, 1990s, or 2000s. All variables are defined in the Appendix. *DifferenceOfCharacteristicBetweenCohortAndPre-1970Firms* is the difference between the average characteristics of a new-list cohort and pre-1970 for each year. We use 100 observations comprised of 40 annual differences for the 1970s cohort, 30 annual differences for the 1970s cohort, 20 annual differences for the 1990s cohorts, and ten annual differences for the 2000s cohorts, from pre-1970 firms, to estimate the regression model

$DifferenceOfCharacteristicBetweenCohortAndPre\text{-}1970Firms_{year} = \beta_1 + \beta_2 \times SubsequentYear + \varepsilon_{Year}$

Convergence (Divergence) is indicated if β_2 has opposite (same) sign as the average difference between pre-1970 and new-list firms and is statistically significant.

	Profitability	IV× 1,000	Earnings volatility
Intercept (β_1× 1,000)	-14.515	467.092	26.106
Slope (β_2× 1,000)	-2.479	11.751	1.100
p-value (β_2)	<0.01	0.02	<0.01
Inference	Convergence	Divergence	Divergence
	R&D	M/B ratio	COGS intensity
Intercept (β_1× 1,000)	-1.995	654.303	-46.318
Slope (β_2× 1,000)	1.521	-3.956	-2.018
p-value (β_2)	<0.01	0.459	<0.01
Inference	Divergence	No significant trend	Divergence
	Special items	Product-launch years	H-index
Intercept (β_1× 1,000)	-2.294	41.220	23.682
Slope (β_2× 1,000)	0.390	1.571	-1.314
p-value (β_2)	<0.01	0.124	<0.01
Inference	Divergence	No significant trend	Divergence