

Firm Selection and Corporate Cash Holdings*

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Abstract

This paper proposes a novel explanation for the secular increase in the cash holdings of public U.S. firms. We show that this fact results from a change in the composition of firms. Since the end of the 70s, the proportion of new economy firms that engage in R&D has increased dramatically. These types of firms enter the Compustat sample with more cash holdings. In contrast, old economy firms' cash holdings have remained stable over time. We use a firm industry model with endogenous entry in the stock market to explore three competing hypothesis: 1) a structural change in the composition of U.S. firms; 2) lower entry costs/better IPO conditions for new economy firms; 3) institutional reasons such as a change in the tax benefit of R&D activities.

*PRELIMINARY & INCOMPLETE. Comments are welcome. Correspondence: Juliane Begenau (jbegenau@hbs.edu) and Berardino Palazzo (bpalazzo@bu.edu).

1 Introduction

Over the last thirty years, cash-holdings of the average U.S. public company have doubled. In theory, a firm’s cash policy is determined by transaction-, precautionary savings-, tax-, or agency-driven motives. Several explanations for the dramatic increase in cash holdings have been advanced by the literature: an increase in agency conflicts, a change in firm characteristics and business environments that has led to an increase in precautionary savings motives, or the stronger presence of multinational firms that are able to expatriate their taxes. What these explanations have all in common is that they focus on changes within the firm.

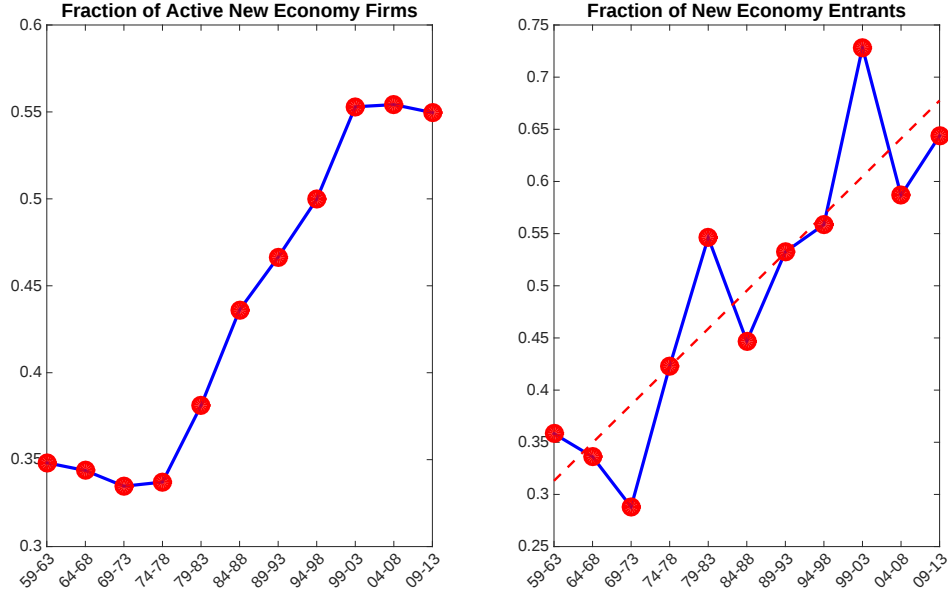
In this paper we propose a novel explanation for the increase in average cash holdings. We argue that the secular increase in cash holdings stems from a change in the composition of firms, that is, the gradual replacement of old economy firms (i.e., low R&D firms) by new economy firms (i.e., high R&D firms)¹. Rather than being driven by a change of cash holding policies within the firm, this secular increase has been driven by a change in the type of firms that decided to go public.

The left panel of Figure 1 shows that the fraction of new-economy firms has increased, a fact largely explained by an increase in the fraction of new-economy entrants (right panel). Why do new-economy firms carry higher cash balances? We argue that their R&D activities require cash financing. The reasons are the following. First, R&D activities contribute to the increase of a firm’s intangible capital stock, which is difficult to collateralize. Second, firms may also find it optimal to finance their R&D activities with cash. When firms use external financing sources to fund R&D, they may have to disclose sensitive information that could give an edge to competitors. Firms can avoid the disclosure of important information by using cash to finance R&D.

The emergence of new-economy firms since the 1980s represents evidence for a shift in the U.S. economy from a goods producing economy to an ideas producing economy. It is thus important to recognize this dichotomy in a data sample of U.S. companies. These two

¹A *new economy* firm belongs to an industry whose average R&D investment amounts to at least 2% of assets over the sample period. However, we show that seven sectors dominate in the “new economy” firm classification.

Figure 1: Industry Composition of U.S. Public Firms (1959-2013)



The left panel of this figure presents the share of new-economy firms in Compustat. The right panel shows the share of new-economy entrants. A *new economy* firm belongs to an industry whose average R&D investment amounts to at least 2% of assets over the sample period. We group firms into cohorts of five years starting from 1959. We define as *entrant* a firms that reports a fiscal year-end value of the stock price for the first time (item *PRCC_F*).

firm types differ not only in their business models (production of goods versus ideas), but also in the way how operations are financed. New-economy firms are characterized by high R&D-to-asset ratios, low tangibility, and high cash-to-asset ratios. Old-economy firms have smaller cash balances, higher tangibility, and do not show an increase in R&D activities or cash balances over the sample period.

This is why it is insufficient to look at changes within the firm to explain the secular increase in cash holdings. Instead, we need to investigate the reasons for the shift in firms' composition. To this end, we develop a novel quantitative model of firm dynamics and firm financing in which firms are either new-economy firms or old-economy firms. We use this model to investigate different explanations for the change in the composition of U.S. public firms. We identify three potential hypotheses. First, a structural change in the overall U.S. economy that makes entry of new-economy firms into Compustat more likely. Second, a decrease in stock exchanges entry cost for new-economy firms so that they find it relatively

cheaper to do an IPO. And finally, we explore institutional reasons as well. In particular, we analyze whether a change in the tax benefit of R&D in 1981 was a driver of the change.

Related Literature

The causes of the increase in cash-to-asset ratios of public U.S. corporations has been studied in numerous papers. However, most papers attribute the change in firms' average cash-holdings to changes within the firm. We propose a novel explanation in which the secular increase in cash-holdings is due to a dramatic shift in the composition of firms.

In theory, there are several reasons for firms to hold cash. A classic motive are transaction costs (e.g. [Baumol \(1952\)](#), [Tobin \(1956\)](#), and [Miller and Orr \(1966\)](#)). For example, taxes levied on repatriated profits can be interpreted as transaction costs. This argument has been advanced by [Foley, Hartzell, Titman, and Twite \(2007\)](#). A precautionary savings motive entices firms to accumulate cash when external financing frictions make it harder to take advantage of attractive investment opportunities ([Froot, Scharfstein, and Stein \(1993\)](#)). [Jensen \(1986\)](#) proposed an agency motive that explains excess cash holdings.

The recent empirical literature has explained the increase in average cash-holdings both with a tax-based explanation ([Foley, Hartzell, Titman, and Twite \(2007\)](#)) and a precautionary savings motive due to higher cash-flow volatilities (e.g. [Bates, Kahle, and Stulz \(2009\)](#)). When asymmetric information are the cause of external financing frictions, firms whose activities are more informationally sensitive have a stronger precautionary savings motive compared to other firms. [Opler and Titman \(1994\)](#) argue that the value of R&D expenditures are particularly informationally sensitive investments. Consistent with this view, [Opler, Pinkowitz, Stulz, and Williamson \(1999\)](#) find that cash rich firms invest more in R&D.

Since [Opler, Pinkowitz, Stulz, and Williamson \(1999\)](#) more papers have found evidence that R&D investment is related to more cash holdings at the firm level, for example [Brown and Petersen \(2011\)](#), [Falato and Sim \(2014\)](#), and [He and Wintoki \(2014\)](#), among many others.

Only a few papers hint at the notion that the increase in average cash-to-asset ratios is

driven by a subset of firms. For example, [He and Wintoki \(2014\)](#) find evidence for the view that the increase can be explained with an increased sensitivity of cash to R&D among R&D intensive firms. Moreover, they find that financial constraints and cash flow volatility are more relevant for R&D intensive firms than for non-R&D intensive firms. [Thakor and Lo \(2015\)](#) argue that standard theory does not capture the financial and business environment of R&D intensive firms sufficiently well, requiring a new theory. In their model, competitive pressure leads firm to choose more R&D investment and higher cash-to-asset ratios.

[Thakor and Lo \(2015\)](#) provide a rationale for why more firms choose a high R&D intensive business model, we argue that the data suggest that two types of firms coexist: R&D-intensive or new-economy firms and non-R&D-intensive firms or old-economy firms. We further show that conditional on the firm’s type financial policies do not change much over time. This relates to the literature on persistence in the corporate capital structure (e.g. [Lemmon, Roberts, and Zender \(2008\)](#)). To our knowledge, we are the first paper to link the secular increase in cash-to-asset ratios to the increased *entry* of firms of a new type: new-economy firms that invest in the production of ideas ².

We study different hypotheses that may have caused the increase in the composition of firms in a firm industry model that builds on [Hopenhayn \(1992\)](#). A key feature of our model is the entry decision of firms, where we follow [Clementi and Palazzo \(2013\)](#). There are two types of firms in the model: old-economy firms and new-economy firms. We model the old economy firm type similarly to [Begenau and Salomao \(2015\)](#) who study the business cycle dynamics of financial policies in a firm industry model with aggregate shocks and entry and exit. Debt is preferred over equity because of a tax-advantage. The old-economy firms invest in tangible capital and pledge tangible capital as collateral to access debt financing. We model new economy firms similar to [Riddick and Whited \(2009\)](#). These firms build a stock of intangible capital that cannot be collateralized via R&D spending. Therefore, they can only finance themselves with equity or with internal funds.

The paper is organized as follows. The next section documents that the increase in

²[Fama and French \(2004\)](#) also document the compositional shift of U.S. public companies over the last thirty years, however they do link this phenomenon to a change in corporate financing policies.

average cash holdings of U.S. public firms can be explained with a shift in the composition of firms. Section 3 presents the model. Section 4 explores which of the three hypotheses can account for the increase in new-economy firms in Compustat. Section 5 concludes.

2 Facts

In this section, we show that the secular increase in the cash-to-asset ratio has been driven by a change in the type of firms that decided to go public, rather than being driven by a change of cash holding policies within the firm. New economy firms have entered in increasing number, relative to old economy firms, and with higher and higher cash balances, thus driving up the cash holdings of the typical U.S. public company.

We also show that new-economy and old economy firms can be considered as two different types of firms, both in their production process and in their financial structure. New-economy firms are characterized by high R&D-to-asset ratios, low tangibility, high cash holdings, and a low level of long-term debt relative to their assets. On the other hand, old-economy firms have smaller cash balances, higher tangibility, do not show an increase in R&D activities or cash balances over the sample period, and have a higher level of long-term debt relative to their assets. These differences in production and financing activities are persistent, i.e., new and old economy firms do not become similar over time.

2.1 New Economy Firms: Data and Definitions

We use accounting data from the annual Compustat database over the period 1959-2013. We exclude financial firms (SIC codes 6000 to 6999) and utilities (SIC codes 4900 to 4999) and we only consider firms incorporated in the United States and traded on the three major exchanges: NYSE, AMEX, and NASDAQ.

A *new economy* firm belongs to an industry (defined using a three-level digit *SIC* code) whose average R&D investment amounts to at least 2% of assets over the period 1959-2013. We obtain very similar results if we narrow down our definition using the seven specific industries that account for the bulk of new economy entrants. These industries are:

Computer and Data Processing Services (*SIC* 737, 26% entrants), Drugs (*SIC* 283, 15% entrants), Medical Instruments and Supplies (*SIC* 384, 9% entrants), Electronic Components and Accessories (*SIC* 367, 8% entrants), Computer and Office Equipment (*SIC* 357, 7% entrants), Measuring and Controlling Devices (*SIC* 382, 5% entrants), and Communications Equipment (*SIC* 366, 5% entrants).

In order to follow the dynamics of an entering cohort, we sort firms into eleven cohorts by considering non-overlapping periods of 5 years starting with the window 1959-1963. This definition is fairly standard in the firm dynamics literature. We define as *entrant* a firm that reports a fiscal year-end value of the stock price for the first time (item *PRCC_F*)³.

2.2 Firm Characteristics at Entry

We argue that investment and financing decisions within the firm (i.e., a firm decides to do more R&D and hold more cash over time) play a secondary role in explaining the change in average cash-holdings relative to the selection effect induced by the entry dynamics. New entrants have a larger cash balance upon entry and their increasing number in the cross-section of firms has lifted up the cash-to-asset ratio.

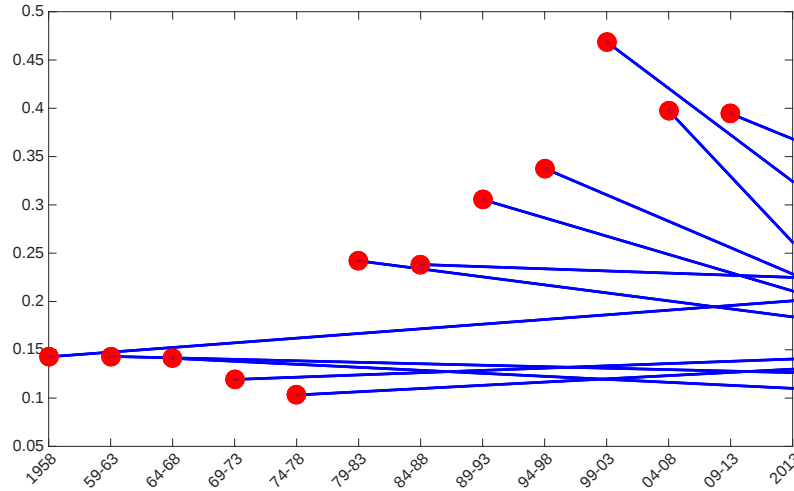
Figure 1 shows that the proportion of new-economy firms has increased from around 35% in the beginning of the 1980s to 55% in 2013 and that, starting in the mid-1980s, the majority of new firms entering into the Compustat sample (IPO) are new-economy firms.

Figure 2 presents the evolution of the cash-to-asset ratio at the cohort level starting with the 1959-1963 cohort. The red dot is the average cash holdings at entry for each cohort. The straight blue line links the initial average cash holdings upon entry to the average cash holdings of the cohort in 2013. A negative (positive) slope means that the average cash holdings at the cohort level has declined (increased). The first observation is the average cash holdings of incumbent firms in 1958. Two facts emerge. First, there is an increase

³To validate our definition of entry in a stock exchange, we compare our entry year with the IPO year reported by Jay Ritter over the period 1975-2014. We are able to merge 56% of our entry companies with the ones in Ritter's dataset. 98% of the matched companies' entry year is the same or one year larger than the reported IPO year in Ritter's dataset. The latter can be found at <http://bear.warrington.ufl.edu/ritter/ipodata.htm>

in initial cash holdings over time, new cohorts enter with higher and higher cash balances. Second, the majority of cohorts deplete cash: at the cohort level there is hardly a secular increase.

Figure 2: Average Cash Holdings at Entry (1959-2013)

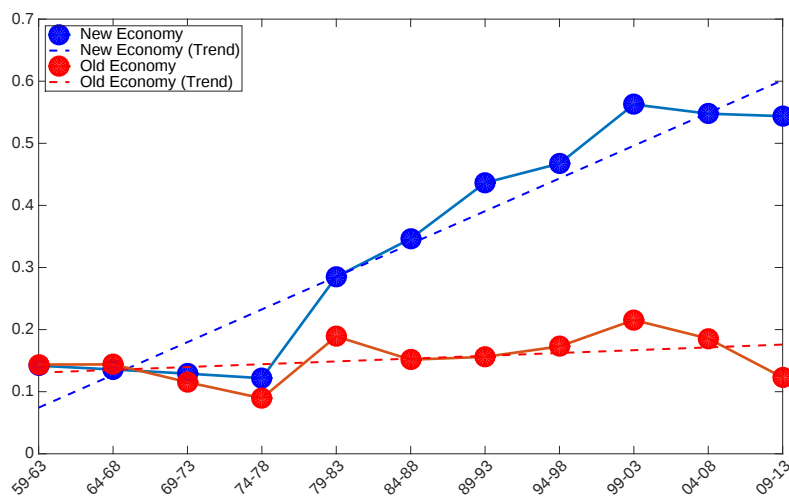


The figure reports the evolution of the cash-to-asset ratio for U.S. public companies for eleven 5-year cohorts over the period 1959-2013. The red dot denotes the average cash holdings at entry for each cohort. The first observations is the average cash holdings of incumbent firms in 1958. The straight line connects the initial average cash-holdings to the average holding in 2013 for each cohort.

When we compare the average cash holdings at entry by cohort and industry (see Figure 3), we observe that new economy firms have entered with higher and higher cash balances over time, while old economy firms have hardly experienced an increasing trend of their cash balances upon entry. That is, the typical old-economy U.S. public company has not increased the cash balance upon entry during the last thirty years. This fact highlights the importance of entry dynamics and composition effects that have so far received little attention in the literature.

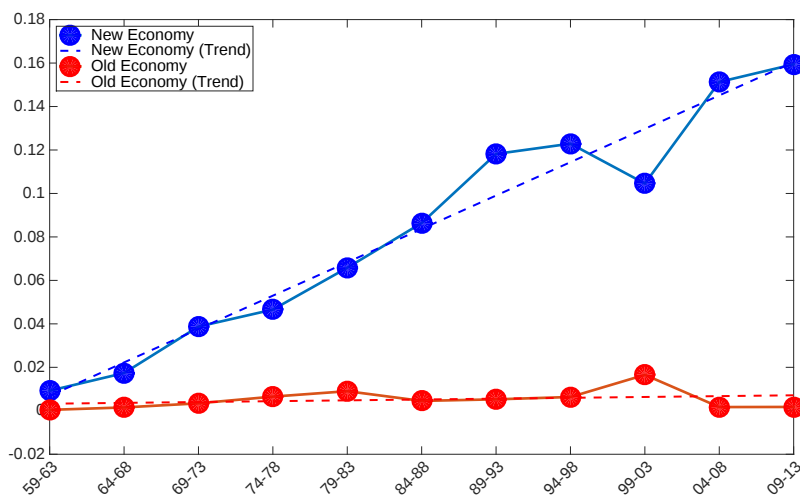
Figure 4 shows an almost identical pattern for the R&D-to-asset ratio at entry by cohort and industry. The literature has established a strong correlation between R&D investment and cash holdings and it has been suggested that an increase in R&D activities of firms could be responsible the secular increase in cash-holdings. Figure 4 provides evidence for a

Figure 3: Average Cash Holdings by Cohort at Entry (1959-2013)



The figure reports the average cash-to-asset ratio for U.S. public companies at entry for eleven 5-year cohorts over the period 1959-2013. The red line refers to old economy firms, while the blue line to new economy firms. The straight dashed line is the linear trend.

Figure 4: Average R&D by Cohort at Entry (1959-2013)



The figure reports the average R&D-to-asset ratio for U.S. public companies at entry for eleven 5-year cohorts over the period 1959-2013. The red line refers to old economy firms, while the blue line to new economy firms. The straight dashed line is the linear trend.

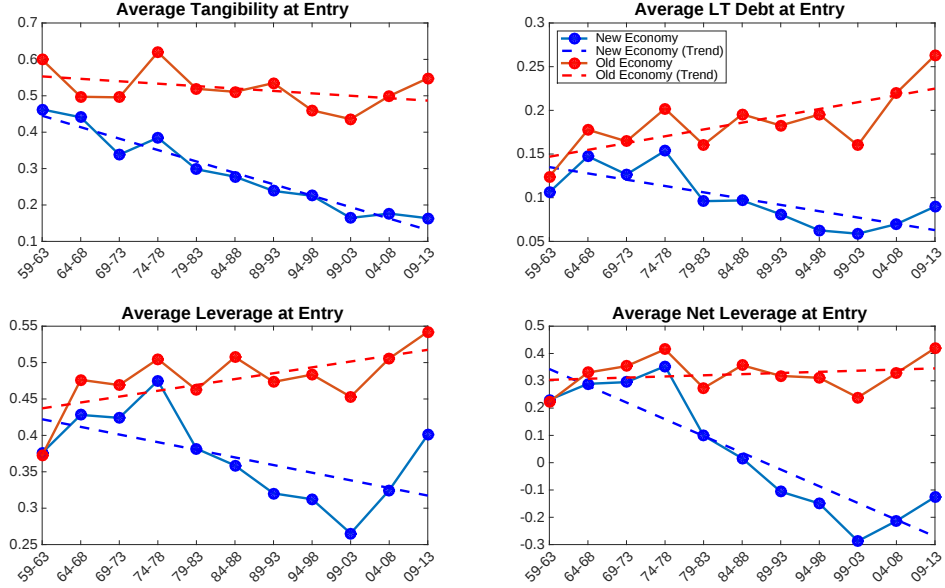
slightly different story. It shows that new entrants exhibit strikingly different R&D activities already at entry while there seems to be no evidence for a change in R&D activities for old

economy firms.

New economy and old economy entrants do not differ only in their cash balance and R&D activity. Figure 5 reports other firm characteristics at entry by cohort that highlight the differences in their business models (production of goods versus ideas) and in their financing sources. The top left panel shows how new economy firms have entered with less and less tangible assets, while old economy firms have experienced a much less dramatic change of tangibility upon entry. The average tangibility, measured as the ratio of gross property, plant and equipment over total assets, was around 50% for new economy entrants at the beginning of the 1960s, a value close to 60%, the average tangibility of old economy entrants. After 50 years, new economy entrants have a tangibility slightly larger than 15% of total assets, while for old economy firms this value is around 55%. The decrease in tangibility for new economy firms has been coupled with a decrease in the amount of long-term debt outstanding that have witnessed a recovery only in the mid 2000s (top right panel of Figure 5). On the other hand, old economy firms have witnessed an increase in the amount of long-term debt outstanding relative to assets. The typical old economy entrant had a value of long-term debt outstanding equal to 12% of total asset in the early 1960s. This value has more than doubled in 50 years and the typical old economy entrant in the last cohort (2009-2013) had a value of long-term debt outstanding equal to 26% of total asset.

Leverage and net leverage (bottom left and right panels of Figure 5, respectively) are very similar and move in the same fashion for the first four cohort and they start to diverge in opposite directions at the beginning of the 1980s when the cash-to-asset ratio also begins to diverge. Old economy firms experience an increase in the average leverage upon entry coupled with an increase in net leverage. New economy firms are characterized by a decrease in leverage and a even more dramatic decrease in net leverage driven by the sharp increase in cash holdings. By the beginning of the 1990s, the typical new economy entrant had a negative net leverage.

Figure 5: Other Firm Characteristics by Cohort at Entry (1959-2013)



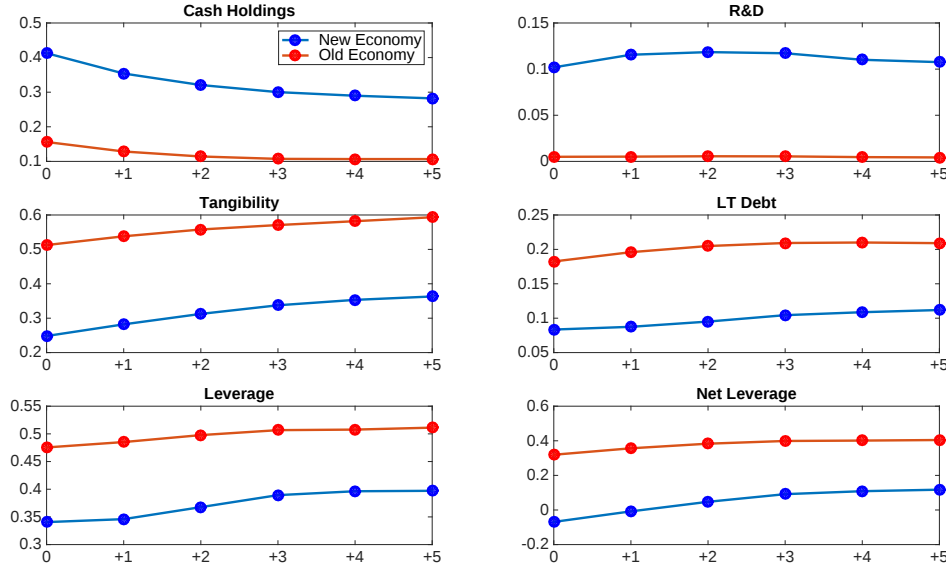
The figure reports the average long-term debt to assets ratio (item *DLTT* over item *AT*), the average tangibility (item *PPEGT* over item *AT*), the average net-leverage (item *LT* net of item *CHE* over item *AT*), and the average leverage (item *LT* over item *AT*), for U.S. public companies at entry for eleven 5-year cohorts over the period 1959-2013. The red line refers to old economy firms, while the blue line to new economy firms. The straight dashed line is the linear trend.

2.3 Post-Entry Dynamics

The previous section has shown that new entrants enter with higher and higher cash-to-assets ratios. What happens to their cash holdings in the subsequent years after entry? Figure 6 reports the average cash holdings for new entrants from the entry year (year 0) up to five years after entry (year 5) together with other key firm-level characteristics.

Both new and old economy firms deplete their cash holdings after the entry year. New economy firms experience a change in cash holdings over the five year period equal to 0.13, while old economy firms decrease them by 0.05. The difference in average cash holdings between the two set of firms decreases during the first two years after entry and then stays constant around 0.18. The R&D activity for new economy firms stays constant in the five years after entry and fluctuates around 0.11. At the same time, the R&D activity of old economy firms does not show any increase in the post entry period and fluctuates around 0.5% of total assets.

Figure 6: Dynamic Evolution Post-Entry



The figure reports the average value from entry (year 0) up to five years after entry (year 5) of the following firm-level characteristics: cash holdings, R&D expenditure, long-term debt, tangibility, leverage, and net leverage. The red line refers to old economy firms, while the blue line to new economy firms.

Both categories of firms show an increase in their post entry values for long-term debt, tangibility, leverage, and net leverage. However, these values are highly persistent and the difference at the entry stage survives for the entire post-entry period. In short, new and old economy firms do not show any sign of convergence in key firm-level characteristics linked to their productive and financing structure.

2.4 Firm Dynamics: Growth Rates, Survival Rates, and Relative Size at Entry

In this section, we explore some key quantities widely used in the firm dynamics literature to further highlight the peculiarities of firms entering in the three major stock exchanges over the past 55 years. We will use these quantities as a guidance to calibrate the entry process in our model economy.

We start by comparing the relative size of new entrants with the size of incumbent public firms. Each year, we measure size using four different variables: total employment (item

EMP), total assets (item *AT*), sales (item *Sale*), and net property, plant, and equipment (item *PPENT*). The relative size of an entrant in a give year t is the average size of entrants in year t divided by the average size in year t of firms that were public in year $t - 1$ and t . Table 1 reports the time-series average of the 55 annual values evaluated over the period 1959-2013. As we can see, new entrants are on average smaller and their size varies between 15% and 20% of the size of incumbents, depending on the size measure we use. However, new economy entrants are on average much smaller than old economy entrants and their relative size goes from 23.2% if we measure size with sales to 44.1% if we measure size with total assets.

Table 1: Relative Size of Entrants

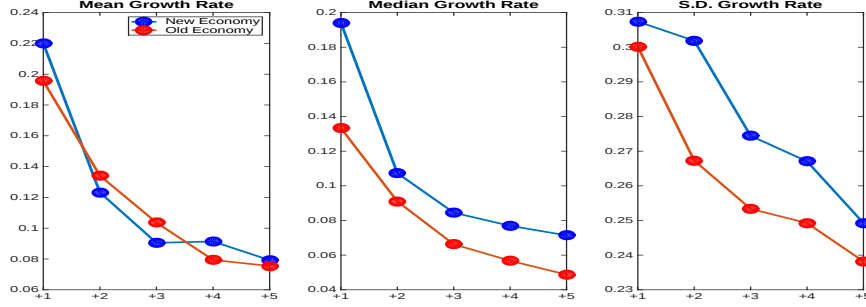
	Employment	Assets	Sales	PPENT
All Entrants	0.195	0.161	0.174	0.151
New Economy	0.102	0.100	0.090	0.060
Old Economy	0.303	0.227	0.267	0.259
Ratio New-Old	0.337	0.441	0.337	0.232

Figure 7 reports the growth rates of employment (top panel) and sales (bottom panel) during the five years after entry for new and old economy firms. It is a well established fact in the firm dynamics literature that a firm's average growth rate and its volatility are decreasing in its size and age. The figure shows that average growth rates of surviving firms decline over time as their median and volatility, a finding consistent with the available empirical evidence. Even if new economy firms are smaller than old economy ones, we do not see a stark difference in their average growth rates, as predicted by their relative size. On the other hand, the median and the volatility of the growth rate for new economy firms are always larger than the corresponding values for old economy firms.

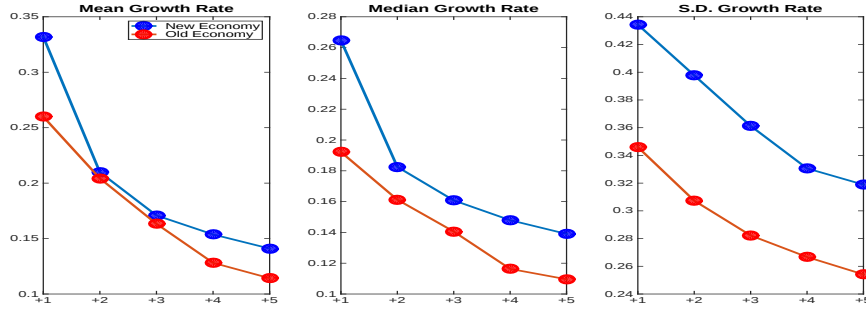
To conclude, we report the exit rates of new entrants during the first five years in Figure 8. We use a broad definition of exit and assume that a firm exits when it stops reporting a value for total assets in Compustat. As a consequence, a firm can exit the sample because it goes bankrupt, it mergers with another firm, it is acquired by another firm, or it goes

private. Figure 8 shows that both types of firms witness a decrease in the exit rate as they age. In addition, new economy firms, being smaller, have a larger exit rate. The difference in exit rates between the two types of firm almost vanishes after five year.

Figure 7: Growth Rates



(a) Employment Growth Rates



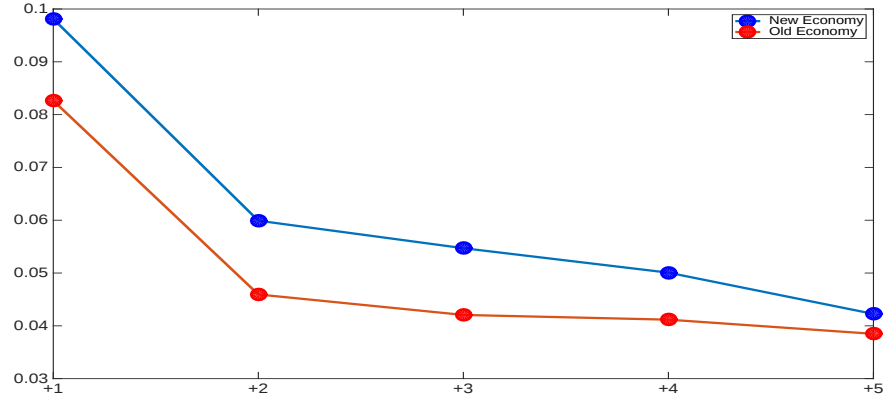
(b) Sales Growth Rates

This figure reports the average growth rate of employment (top panel) and sales (bottom panel) for new economy entrants (solid blue line) and old economy entrants (solid red line). Data are winterized at the top and bottom 1% to minimize the impact of extreme observations.

3 Model

In our model economy, firms can be of two types: high tangibility firms (i.e., new economy firms) and low tangibility firms (i.e., old economy firms). Since our focus is on the dynamics of the cash-to-assets ratio's cross-sectional average, we simplify the setup assuming that firms can either produce using physical capital or intangible capital and that only the former can be pledged as collateral to issue debt.

Figure 8: Exit Rates



This figure reports the exit rate for new economy entrants (solid blue line) and old economy entrants (solid red line).

We assume the existence of a time-invariant mass of potential firms that can become public (potential entrants in the stock market) by paying a fixed IPO cost. The potential entrants are heterogenous because they can be either new economy or old economy firms. In the benchmark economy, the proportion of potential entrants of the new economy type is kept constant.

3.1 Incumbent problem

3.1.1 Technology

We assume that both types of firms share the same functional form for the production function:

$$y_t = e^{z_t} k_{j,t}^\alpha$$

where j indicates if the firm uses tangible ($j = o$) or intangible capital ($j = n$) and z_t is an idiosyncratic productivity shock that evolves according to

$$z_{t+1} = \mu + \rho z_t + \epsilon_{t+1}.$$

The law of motion for the capital stock is

$$k_{j,t+1} = (1 - \delta_j)k_{j,t} + x_{j,t},$$

where δ_j is the depreciation rate and $x_{j,t}$ is the capital investment at time t . We assume $\delta_n > \delta_o$ ⁴.

3.1.2 Financing

Firms can finance their operations internally by transferring cash from one period to the next at an accumulation rate $\widehat{R}$. For the time being, we assume that $\widehat{R} = R - \tau(R - 1) < R$, namely internal accumulation of cash delivers a return lower than the risk-free rate because the firm pays taxes on the interests. At the same time, firms can raise external resources by issuing equity or debt. Equity financing is costly: raising e_t requires the payment of $H(e_t)$ ⁵

$$H(e_t) = \kappa_0 + \kappa_1 e_t + \frac{\kappa_2}{2} (e_t)^2.$$

Debt financing is attractive because there is a tax advantage: interests paid on corporate debt are tax deductible. There is unlimited liability and thus debt is priced at the riskless rate. However, the amount of debt issuance is limited by a collateral constraint: a firm can borrow up to the present discounted value of next period depreciated capital level $((1 - \delta_o)k_{o,t+1}/R)$. Since new economy firms have only intangible capital that cannot be collateralized, they can only use cash and equity.

3.1.3 Old economy incumbent's problem

At time t , the firm's budget constraint is

$$(1) \quad d_t = w_t + b_{t+1} - \frac{s_{t+1}}{\widehat{R}} - x_{o,t+1}.$$

⁴Hall (2007) provides evidence for a larger depreciation rate for the R&D capital stock.

⁵For a justification of this functional form see Hennessy and Whited (2007).

The firm can use the total resources available to distribute dividends (d_t), invest in tangible capital ($x_{o,t}$), or to accumulate cash internally $s_{t+1}/\widehat{R}$. If the initial net worth w_t is negative, then the firm raises external funds to repay pre-existing liabilities. Given that there is a tax advantage of debt, the firm will first issue debt b_{t+1} and then use the more expensive equity. The maximum amount of debt that the firm can raise at time t equals $(1 - \delta_o)k_{o,t+1}/R$. If d_t is negative (i.e. the firm has exhausted its debt capacity and uses equity to finance the initial time t liabilities), the equity issuance cost is $\kappa_0 + \kappa_1 d_t + \frac{\kappa_2}{2} (d_t)^2$. In what follows, $\mathbf{1}_{[d_t \leq 0]}$ is an indicator function that takes value 1 only if the firm needs to issue equity at time t .

The firm's $t + 1$ net worth is

$$\begin{aligned} w_{t+1} &= s_{t+1} + (1 - \tau)e^{z_{t+1}}k_{o,t+1}^\alpha - (R - \tau(R - 1))b_{t+1} \\ (2) \qquad &= s_{t+1} + (1 - \tau)e^{z_{t+1}}k_{o,t+1}^\alpha - l_{t+1}^*. \end{aligned}$$

The interest paid on corporate debt is tax deductible, so the net repayment is equal to the promised repayment, Rb_{t+1} , net of the reduction in corporate taxes, $\tau(Rb_{t+1} - b_{t+1})$. If the realized earnings are negative, the firm does not pay corporate taxes but still benefits from the tax advantage of debt. To simplify the notation, we introduce a new variable, l_{t+1}^* , that is equal to the repayment to the bondholders net of the tax deduction. Notice that by construction b_{t+1} equals $\frac{l_{t+1}^*}{R}$. It follows that we can summarize cash and debt in a single variable $l_t = s_t - l_t^*$, the net leverage of the firm. The time t value of an old economy firms solves the following functional equation

$$(3) \qquad V^o(w_t) \equiv \max_{l_{t+1}, x_{o,t+1}} (1 + H(d_t) \mathbf{1}_{[d_t \leq 0]})d_t + \frac{1 - \phi}{R} E_t[V_{t+1}]$$

subject to

$$\begin{aligned}
(4) \quad d_t &= w_t - \frac{l_{t+1}}{\widehat{R}} - x_{o,t+1}, \\
(5) \quad k_{0,t+1} &= (1 - \delta_o)k_{o,t} + x_{o,t+1}, \\
(6) \quad w_{t+1} &= (1 - \tau)e^{z_{t+1}}k_{o,t+1}^\alpha + l_{t+1}, \\
(7) \quad \frac{l_{t+1}}{\widehat{R}} &\leq \frac{(1 - \delta_o)k_{o,t+1}}{\widehat{R}},
\end{aligned}$$

where ϕ is the exit probability between time t and $t + 1$.

3.1.4 New economy incumbent's problem

A new economy firm cannot rely on external debt given the lack of collateral. Thus, the only difference with the functional equation of an old economy firm is in having $l_t = s_t$. It follows that the time t value of a new economy firms solves the functional equation below

$$(8) \quad V^n(w_t) \equiv \max_{s_{t+1}, x_{n,t+1}} \left((1 + H(d_t) \mathbf{1}_{[d_t \leq 0]}) d_t + \frac{1 - \phi}{R} E_t[V_{t+1}] \right)$$

subject to

$$\begin{aligned}
(9) \quad d_t &= w_t - \frac{s_{t+1}}{\widehat{R}} - x_{n,t+1}, \\
(10) \quad k_{n,t+1} &= (1 - \delta_n)k_{n,t} + x_{n,t+1}, \\
(11) \quad w_{t+1} &= (1 - \tau)e^{z_{t+1}}k_{n,t+1}^\alpha + s_{t+1}, \\
(12) \quad s_{t+1} &\geq 0,
\end{aligned}$$

where ϕ is the exit probability between time t and $t + 1$. Choosing cash holdings (s_{t+1}) and investment ($x_{n,t+1}$) determines the next period net worth (w_{t+1}).

3.2 Entry

Every period there is a constant mass $M > 0$ of firms that decide to go public. M is the sum of $M_n > 0$, the mass of new economy firms that are private, and $M_o > 0$, the mass of old economy firms that are private. Firms that decide to go public are randomly drawn

from the stationary distribution of private firms. To simplify the analysis, we assume that all of the private firms have a constant value for the average firm-level productivity equal to 1 (i.e., $\mu = 0$).

Going public entails a permanent increase of the average firm-level productivity. If a firm decides to go public, it will face an idiosyncratic productivity shock after entry that evolves according to

$$z_{t+1}^* = \mu^* + \rho z_t^* + \epsilon_{t+1}^*,$$

where $\mu^* > 0$. Following [Clementi and Palazzo \(2013\)](#), we assume that each potential entrant in the stock market receives a signal q about its future productivity, where the signal follows a Pareto distribution $q \sim Q(q)$. Conditional on entry, the distribution of the idiosyncratic shocks in the first period of operation is $F(z'|q)$, strictly decreasing in q . Firms that decide to go public pay an IPO cost c_e . The value function for an entrant of

$$(13) \quad V^{E,i}(q) = \max_{x_{i,t+1}, L_{i,t+1}} \left\{ -\frac{l_{i,t+1}}{\widehat{R}} - x_{i,t+1} + \underbrace{H\left(-\frac{l_{i,t+1}}{\widehat{R}} - x_{i,t+1}\right)}_{Eq. Iss. cost} + \frac{1}{R} E_{z_{t+1}^*} [V^n(w_{t+1})] \right\}.$$

A potential entrant chooses to stay private or to pay an IPO cost, go public, and enjoy a higher average firm-level productivity. A firm will go public if and only if

$$V^{E,i} \geq V^{P,i} + c_{e,i},$$

where $V^{E,i}$ is the value of going public for a firm that is of type, $V^{P,i}$ is the value of staying private, and $c_{e,i} > 0$ is the IPO (entry) costs $\forall i \in \{o, n\}$.

3.3 Firm industry equilibrium

Denote ω as the fraction of new economy firm. Given ω and the riskless rate R , a recursive competitive equilibrium consists of (i) value functions $V^i(w)$ and $V^{E,i}(q)$, (ii) policy functions

$l_i^{*'}(w)$ and $x_i'(w)$ and (iii) bounded sequences of incumbents' measure $\{\Gamma_t^i\}_{t=1}^\infty$ and entrants' measures $\{\varepsilon_t^i\}_{t=0}^\infty \forall i \in \{o, n\}$ such that

1. $V^i(w)$ and $l_i^{*'}(w)$ and $x_i'(w)$ solve the incumbents problem $\forall i \in \{o, n\}$
2. $V^{E,i}(q)$ and $l_i^{*'}(w)$ and $x_i'(w)$ solve the entrants problem $\forall i \in \{o, n\}$
3. For all Borel sets $Z \times W \times L \times X \times \Re$ and $\forall t \geq 0$,

$$\varepsilon_{t+1}^i(W) = M_i \int_Z \int_{Be^i(W)} dQ(q) d(F(z'^*|q))$$

where $Be^i(W) = \{p^{x^i} \text{ and } p^{l^i} \text{ s.t. } l_i'(q) \in L, x_i'(q) \in X \text{ and } V^{E,i} \geq V^{P,i} + c_{e,i},\}$ denotes the policy functions.

4. For all Borel sets $Z \times W \times L \times X \times \Re$ and $\forall t \geq 0$,

$$\Gamma_{t+1}^i(W') = (1 - \phi) \int_Z \int_{B^n(W)} d\Gamma_t^i(W) dF(z'|z) + \varepsilon_{t+1}^i(W)$$

$$B^i(W) = \{w'\} \text{ and } \omega = \Gamma_{t+1}^n(W') / \Gamma_{t+1}^o(W').$$

The firm distribution evolves in the following way. A mass of entrants receives a signal and some decide to enter. The signal q determines the productivity level of the following period. Firms choose debt or savings and investment in their capital type (intangible or tangible). This determines the net worth for the following period. Conditional on not exiting, incumbent firms pick period's investment, internal or external funds. The shocks follow a Markov distribution.

4 Parametrization

5 Experiments

5.1 Institutional: R&D tax advantage

5.2 Composition outside (private sector) has changed

We can model this by changing M_i the mass of potential entrants of type i over time.

5.3 Entry costs have fallen for new economy firms

We can model this scenario through a change in $c_{e,i}$.

Conclusion

In this paper we highlight the importance of entry to explain the capital structure dynamics for the typical U.S. public company during the last thirty years.

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