



BANK OF CANADA
BANQUE DU CANADA

Discussion Paper/Document d'analyse
2008-16

Financial Constraints and the Cash-Holding Behaviour of Canadian Firms

by Darcey McVanel and Nikita Perevalov

Bank of Canada Discussion Paper 2008-16

October 2008

Financial Constraints and the Cash-Holding Behaviour of Canadian Firms

by

Darcey McVanel and Nikita Perevalov

Monetary and Financial Analysis Department
Bank of Canada
Ottawa, Ontario, Canada K1A 0G9
dmcvanel@bankofcanada.ca
nperevalov@bankofcanada.ca

Bank of Canada discussion papers are completed research studies on a wide variety of technical subjects relevant to central bank policy. The views expressed in this paper are those of the authors. No responsibility for them should be attributed to the Bank of Canada.

Acknowledgements

We thank Jason Allen, Francisco Covas, Ben Fung, Toni Gravelle, Ron Morrow, and Jonathan Witmer, and participants of the Bank of Canada seminar, for their helpful comments. We thank Simon Lai and Wendy Kei for excellent research assistance, and Glen Keenleyside for editorial assistance. Errors and omissions are the responsibility of the authors.

Abstract

The proportion of assets held by the average Canadian firm in the form of cash has increased steadily since the early 1990s, and is now roughly twice as large as in 1990. The literature has established that the cash-holding behaviour of firms is highly correlated with financial constraints and firm characteristics. The authors use a firm-level data set covering Canadian firms from 1980 to 2006 to understand which firm characteristics are associated with higher cash holdings. They find that financial constraints are likely important for explaining firms' higher cash holdings, and that the recent increase in the cash holdings of Canadian firms can be almost entirely explained by changes in firm characteristics. Specifically, higher recent cash holdings are correlated with the average Canadian firm having become smaller, having more variable cash flow, holding lower levels of cash substitutes, having higher expenditure on research and development, and being more likely to be financially distressed. The authors also find that the average Canadian firm has a cash ratio that is only slightly higher than would be predicted by out-of-sample forecasts over the 1990s and 2000s, though the divergence between the actual and predicted values has been increasing in recent years.

JEL classification: G11, G32

Bank classification: Sectoral balance sheet

Résumé

Depuis le début des années 1990, la proportion d'actifs détenus par l'entreprise canadienne moyenne sous forme de liquidités s'accroît régulièrement et a pratiquement doublé au cours de cette période. Des études ont montré que la détention d'actifs liquides est fortement corrélée avec les contraintes financières et les caractéristiques des sociétés. Les auteurs utilisent un ensemble de données individuelles relatives aux entreprises canadiennes pour les années 1980 à 2006 afin de cerner les caractéristiques associées au maintien d'un volant important de liquidités. Ils constatent que les contraintes financières constituent probablement un élément décisif à cet égard et que l'évolution des caractéristiques des entreprises explique presque entièrement l'accroissement récent de leurs actifs liquides. Ils font notamment ressortir une corrélation entre ce dernier phénomène et le fait que la taille de l'entreprise moyenne a diminué au Canada, que ses flux de trésorerie sont plus variables, qu'elle détient moins de substituts d'actifs liquides, que ses dépenses en recherche et développement ont augmenté et qu'elle est plus susceptible de connaître des difficultés financières. Les auteurs constatent en outre que le ratio des liquidités de l'entreprise canadienne moyenne est seulement légèrement supérieur à ce qu'indiqueraient les prévisions hors

échantillon pour les décennies 1990 et 2000, bien que l'écart entre les valeurs réelles et prévues se soit creusé ces dernières années.

Classification JEL : G11, G32

Classification de la Banque : Bilan sectoriel

1 Introduction

Under the assumption that perfect capital markets do not have transactions costs, the costs of internally generated and external funds are equal and firms can readily borrow as required to finance investment or cover a cash shortfall.¹ Firms therefore do not have any incentive to accumulate high amounts of liquid assets; rather, their liquid asset holdings react passively to cash flow. It is generally accepted, however, that capital markets are imperfect, given asymmetric information between borrowers and lenders.² Depending on firm characteristics, information asymmetries may be greater for some firms. Those firms for which information asymmetries are important tend to be financially constrained: they must borrow at a higher cost, if they are indeed able to borrow at all. Together with the transactions costs associated with accessing borrowed funds, this creates an incentive for firms to hold liquid assets and implies that such holdings will depend on individual firms' characteristics.

What is described above corresponds to the static trade-off theory of cash holdings, which a large body of literature has tested and supported. Specifically, using microdata, Kim, Mauer, and Sherman (1998), Opler et al. (1999), and Bates, Kahle, and Stulz (2006) find support for this theory based on the actions of U.S. firms, and Dittmar, Mahrt-Smith, and Servaes (2003) and Couderc (2005) find support for it based on the actions of internationally located firms. Importantly, Couderc also finds support among Canadian firms. These papers, which stem from Opler et al. (1999), generally also test whether firms' liquidity holdings are set to maximize shareholder value, where a buffer of liquid assets is desirable to minimize the cost of frequently accessing capital markets, encountering financial distress, and having to forgo profitable investment opportunities (the precautionary theory of cash holdings), or set so that management can pursue its own objectives (the managerial opportunism theory). Results generally support the former theory, although a number of researchers find that firms are, on average, holding somewhat more liquidity than is predicted by that model.

While the focus of the above-noted papers is not on establishing the impact of financial constraints on cash holdings, they generally find that firms that have a higher likelihood of financial constraint, such as being smaller, younger, having lower net income, and being less indebted, tend to hold more cash. Those that have a higher cost of being financially constrained because they have greater investment opportunities (i.e., positive net present value projects) also

1. Assuming the firm is not in financial distress.
2. Schaller (1993) and Chirinko and Schaller (1995) find that asymmetric information and finance constraints are important for Canadian firms over the 1973–86 period.

tend to hold more cash. Cash may also be important for helping constrained firms avoid default: in a study of U.S. firms, Davydenko (2007) finds that some firms default solely because of their inability to access external funds.³

The literature on the cash-flow sensitivity of investment develops a methodology to classify firms as being either financially constrained or unconstrained, and investigates whether investment spending by the constrained firms is more sensitive to cash flow than that by the unconstrained firms.⁴ Researchers who find this result include Fazzari, Hubbard, and Petersen (1988), Baum and Thies (1999), Almeida, Campello, and Weisbach (2004), and Acharya, Almeida, and Campello (2007) for the United States; Schaller (1993) and Chirinko and Schaller (1995) for Canada; and Hoshi, Kashyap, and Scharfstein (1991) for Japan. Kaplan and Zingales (1997) and Cleary (1999) find that the investment decisions of less financially constrained firms are more sensitive to internal cash flow than those of more financially constrained firms; however, this result may be related to the different methods those researchers used to classify firms as being financially constrained.

We find that the firms holding the highest cash ratios are more likely to be financially distressed, have higher cash-flow variability, are smaller, and have higher expenditures on research and development (R&D). These factors indicate that financial constraints are important in explaining cash holdings. Our model, using 1980s data, performs very well in predicting cash holdings in the 1990s and 2000s. This indicates that, consistent with Bates, Kahle, and Stulz (2006), the increase in cash holdings by the average firm can be explained by changes in firm characteristics, rather than by an exogenous change in firms' demand for cash over time. Therefore, barring an important change in the typical Canadian firm's characteristics, cash holdings are likely to remain elevated.

In this paper, we are interested in establishing which characteristics are displayed by firms holding high cash balances, with a focus on indicators of financial constraint.⁵ To do so, we follow the methodology of Opler et al. (1999) and Bates, Kahle, and Stulz (2006). In section 2, we first describe the data and the time-series evolution of a number of key variables. In section 3, we divide firms into four groups, according to their cash/asset ratios, and discuss how the

-
3. Default events include bankruptcy filings, bond payment omissions, and distressed bond exchange offers.
 4. We did attempt to divide firms in our sample into constrained and unconstrained groups, but we were unsatisfied with the stability of the groupings. Therefore, we did not conduct separate regressions for constrained and unconstrained groups.
 5. The focus of this paper is on firms' cash stock (the accumulation of cash on a firms' balance sheet), rather than on its cash flow (the cash generated by income).

characteristics of these firms differ from other firms. In section 4, we run a number of panel regressions to establish a more formal link between cash holdings and firm characteristics. In section 5, we estimate a cash-holding regression for the 1980s and apply it to the 1990s and 2000s to determine whether cash holdings of firms differ from what is predicted by the model, or whether firms are currently holding, on average, a higher proportion of cash because their characteristics have changed. In section 6, we offer some conclusions.

2 The Data

Our results are based on financial statements data from the *Globe and Mail Report on Business* database, which contains annual balance sheets, income statements, statements of retained earnings, stock information, statements of changes in financial position, and miscellaneous and industry-specific information on more than 3,500 Canadian companies between 1973 and 2006.⁶ Both public and private firms are contained in this data set, but coverage of public firms is much more extensive than that of private firms: 18 per cent of firms in our sample are private firms, comprising 23 per cent of total assets.

We are interested only in Canadian, non-regulated, non-financial firms.⁷ Financial firms will obviously hold liquidity to facilitate their day-to-day operations, and both financial firms and utilities may hold liquidity to meet regulatory requirements. To avoid survivor bias, both currently active firms and firms that no longer exist due to a bankruptcy or merger/acquisition are included. Stylized facts are based on nominal values; however, in regressions, nominal series are deflated based on the consumer price index.

To obtain a usable set of observations, we filter the data using standard methods that do not change the ultimate results. Specifically, we must delete firm-years that appear to contain errors. Deletions are made based on the following criteria:

- negative sales or assets,
- an accounting identity is violated by more than 10 per cent, and/or
- the period covered by the annual financial statements differs from 12 months.

6. Variable definitions are provided in Appendix A.

7. The sectors that are excluded from our analysis are banks and other financial firms, and utilities. Pipelines are included but do not affect our results.

In some cases, there are multiple financial statements for the same year. This could result from the firm being involved in a merger or acquisition, changing its fiscal year, or reissuing its financial statements. We delete all but the latest filed financial statement for such a year, to avoid including duplicated and/or erroneous financial statements.

2.1 The time-series properties of key variables

In this section, we consider both the evolution of cash and the changes in firm characteristics that may be motivating firms to hold more cash. Since we are conducting panel-data analysis, we are interested in the behaviour of individual firms' ratios, rather than the economy-wide financial ratios. As a result, we compute each firm's individual ratio, aggregate up, and then compare the mean of the aggregated firm-specific ratios across years in our sample.

2.1.1 Cash, leverage, and cash substitutes

Chart 1 shows the time-series evolution of the cash/total assets ratio, leverage (debt/assets), and net leverage ((debt – cash)/assets). Firms' cash ratios have been steadily trending upwards since the early 1990s. Specifically, the average firm held less than 10 per cent of its assets in cash in 1980, whereas it held over 20 per cent in 2006. This ratio illustrates substantial variation over time, and displays some co-movement with GDP growth.

Not only does cash show an increasing trend in our sample, but both gross and net leverage (or (debt – cash)/assets)) have also trended downwards, indicating that Canadian firms are becoming significantly less indebted. Average firm gross leverage decreased from 24 per cent in 1980 to 15 per cent in 2006. The decrease in net leverage, from 12 per cent to –5 per cent, is even more striking. Canadian data also reveal two results found by Bates, Kahle, and Stulz (2006) for the United States: the decrease in net leverage is even more pronounced than the increase in cash, and, at the end of the sample, firms actually held more cash than debt.

Chart 2 shows that firms made some substitution from other current assets towards cash throughout the sample. Specifically, the average inventory ratio fell from over 10 per cent in the 1980s to less than 6 per cent in the 2000s, which likely reflects better inventory management. The accounts receivables ratio has also trended downwards from the early 1990s onwards. Movement towards cash from other current assets likely reflects improvements in firms' financial management capabilities over time.

Chart 3 shows net working capital ((current assets – current liabilities)/total assets), which illustrates coverage of current liabilities with current assets. This ratio is strongly positive, but it has trended gradually downwards, indicating that firms are, on average, managing their

short-term financial position more closely. When cash is subtracted from the numerator, it reinforces the earlier finding that firms are substituting cash for other current assets as a means to cover their current liabilities.

2.1.2 Changes to firm characteristics

Firms that are younger and smaller may have more trouble obtaining financing, and therefore may hold more cash to facilitate operations. Chart 4 shows that there was a pronounced decline in the average firm size in our sample between 1980 and 2001. In fact, in the 1980s it was approximately twice that of the current decade. The average age of firms in the sample, however, has steadily increased.⁸

There may be either an active or a passive relationship between cash holdings and dividends – firms that do not pay dividends may accumulate more cash, or firms may decide not to pay dividends in order to accumulate cash. Chart 5 shows that there was a decreasing propensity for firms to pay dividends over the period 1980 to 2001 – and a firm was around one-third as likely to pay dividends in 2006 as in 1980. The declining propensity to pay dividends is likely due to two taxation changes that made dividend income less favourable for investors in 1986 and 1987.⁹ Firms' propensity to pay dividends started to increase again in 2001, likely because an increasing number of firms became income trusts over the 2001–06 period.¹⁰ Dividend taxation also became more favourable in 2006, when the government eliminated the double taxation of dividends from large corporations.¹¹

While equivalent analysis is not available for Canada, Fama and French (2001) document U.S. firms' decreasing propensity to pay dividends, and find that it can be explained in roughly equal measures by an exogenous decline in firms' propensity to pay dividends and changes in firm characteristics that make it optimal for fewer firms to pay dividends. Specifically, the average firm in their sample became smaller, and had lower earnings and larger investment expenditures relative to earnings.

8. The average age of firms is biased towards an upward slope: since our data set starts in 1973, the maximum calculated age of firms in 1980 is seven years, whereas they may be substantially older.

9. In 1986, the effective tax rate on dividends was increased by 9 percentage points, and in 1987 the dividend and interest exemption was eliminated. See McKenzie and Thompson (1995) for further details.

10. Payments made to unit holders of income trusts are recorded as dividends in our database. Anderson (2006) notes that the total market capitalization of income trusts on the Toronto Stock Exchange increased fivefold between 2002 and late 2005.

11. See Canada (2006) for further details.

Firms in financial difficulty are less likely to be able to obtain loans, so a higher proportion of financially distressed firms may have high cash holdings. Chart 6 shows the proportion of firms that are insolvent or loss-making in any year – characteristics that may indicate financial distress.¹² The number of loss-making firms increased from an average of 43 per cent in the 1980s to 57 per cent in the 1990s and 65 per cent in the 2000s. The number of insolvent firms (defined as those with liabilities that exceed assets) increased from around 1 per cent in 1980 to 8 per cent in 2001, and then fell to just under 5 per cent in 2006. This ratio has increased compared with the early sample period, though it is very cyclical. Although none of these are perfect measures of financial distress, the fact that all increased from 1980–2001 suggests that an increasing proportion of firms were becoming distressed over this period.

Firms may accumulate cash to realize investment opportunities. Chart 7 shows the proportion of total expense on R&D, which is an indicator of future investment opportunities. This ratio increased substantially from 0.02 per cent in 1980 to 3.5 per cent in 2001, though it fell to 2.6 per cent in 2006. Investment opportunities may also be indicated by market-to-book value; as Chart 8 shows, it has trended upwards since the early 1990s until recently, though it is very volatile. A direct measure of investment is the proportion of assets devoted towards capital expenditure, which has been very volatile but does not show any trend (Chart 8).

If firms face less-certain cash flow, they will have to hold higher cash reserves to ensure that they meet their financial obligations as they come due. Chart 9 shows that cash-flow variability has increased markedly over the sample period, from 5.5 per cent in 1980 to 31 per cent in 2006.¹³

If firms are obtaining more funding through net debt and equity issuance, their cash holdings are likely to be higher, at least for some time after the issuance. Chart 10 shows that the net proceeds of equity issuance seem to have an upward trend, though there is no trend evident from net debt issuance. Both these measures are very volatile.

It is notable that a number of key characteristics changed momentum in 2001. Specifically, the average firm size, propensity to pay dividends, and net working capital excluding cash all reversed their previous downward trends and started to increase, whereas the number of

12. Of course, a firm could display one or more of these characteristics and not actually be distressed. This is especially true for very young firms. We expect firms that are financially distressed to be financially constrained, but not necessarily the other way around.

13. Cash-flow variability is defined as the industry-wide average standard deviation of the ratio of operating cash flow to total assets.

insolvent firms and the R&D expense both reversed previous upward trends and started to fall. All of these things would indicate that the cash ratio should have fallen in 2001, but cash holdings actually gained momentum and remained very high thereafter. An important shift seems to have occurred in 2001, which may have to do with firms becoming more conservative after the 2001 slowdown in economic growth.

2.1.3 Cash holdings by industry

Chart 11 shows the growing importance of industries in the knowledge-based sector: both the number of firms and total assets in these industries increased steadily until 2000, reaching peaks of around 16 per cent and 18 per cent of the totals, respectively. Both the number and proportion of assets held by knowledge-based firms fell in recent years. However, total assets held by these firms were 14 per cent of the total of all industries at the end of our sample, compared with 3–4 per cent at the start of the sample. Given that companies in the high-tech sector are, among other things, more likely to have higher spending on R&D, the cash holdings of these firms are likely to be higher than those of firms in other industries. This is borne out by our data.

Table 1 lists selected industries and their average cash ratios over several periods. The table shows that around two-thirds of industries have increased cash holdings in the current decade, compared with the sample average. There is significant variation of liquid asset holdings across sectors. The knowledge-based industries, such as biotechnology and telecommunications, tend to hold a higher proportion of assets in cash. Moreover, biotechnology, computer software and processing, and telecommunications have experienced large increases in cash holdings, as shown by the difference between the long-term and the 2000–06 average cash ratios. These three industries accounted for over 14 per cent of reported liquid balances in the database in 2006, and 5 per cent of total assets. Not surprisingly, they accounted for the disproportionate number of cash-rich firms. Biotechnology and computer software and processing, together, accounted for only about 9 per cent of firms in the database in 2006, but for over 18 per cent of firms in the highest cash quartile in that year. These firms' higher cash holdings may be related to high investment opportunities and R&D spending.

Resource-based industries, particularly the metal mining companies, have also significantly increased their proportional cash holdings, presumably buoyed by higher commodity prices. Almost 30 per cent of total reported liquid assets for 2006 were on the balance sheets of just five of these industries, accounting for the same proportion of total assets.¹⁴ From the resource-based

14. The industries are precious metals, oil and gas producers, metal mines, integrated oils, and integrated mines.

industries, producers of precious metals constituted just over 21 per cent of firms in the database in 2006, but represented over 31 per cent of firms in the top quartile of cash holdings in that year.

3 What are the Characteristics of Firms that Hold Higher Liquid Balances?

All firms, even those that are not financially constrained, will hold some cash given the transactions costs associated with borrowing. Constrained firms will also hold cash for precautionary purposes, and to be able to realize future investment opportunities. In general, a firm's cash holdings will depend both on its degree and cost of financial constraint and its sources and uses of cash. To analyze how these factors affect a typical firm's cash holdings, we divide firms into quartiles according to their cash/asset ratio, test whether there is a statistical difference in the median value of key ratios related to the cost and likely presence of financial constraints, and control values related to sources and uses of funds.¹⁵

3.1 Potential measures of financial constraint

Financially constrained firms are more likely to hold a high proportion of cash, so that they will be able to continue to operate and/or invest if they are unable to borrow in the future. In the literature on investment and cash flow, the following characteristics are often found to be indicators of financial constraint, and they may also be applicable to Canadian firms.¹⁶

- **Size:** Smaller firms generally have less access to, and face a higher cost of, external finance, so are likely to hold more cash. Small firms may also hold more cash because there are economies of scale in cash management. Almeida, Campello, and Weisbach (2004), Hovakimian and Titman (2006), Whited and Wu (2006), and Acharya, Almeida, and Campello (2007) find that small firms are more likely to be financially constrained. As Table 2 shows, our results confirm that Canadian firms that hold more cash tend to be smaller; the median size of firms in the highest quartile of cash holdings is over five times lower than that of firms in the lowest quartile. This relationship continues throughout the time period considered.
- **Dividend payment:** By paying dividends, a firm is leaving itself less cash flow for other purposes, so a constrained firm is unlikely to devote scarce available cash to dividends. Dividend payments may also act as a control variable, since a firm that pays out dividends is less likely to be able to accumulate a large amount of cash. Fazzari, Hubbard, and Petersen (1988), Cleary (1999), Almeida, Campello, and Weisbach (2004),

15. The group of firms included for each stylized fact is the group for which we have the relevant information.

16. Almeida, Campello, and Weisbach (2004) hypothesize that the best indicators of financial constraint should have the highest pair-wise correlations. In unreported results, we find that dividend payment, age, size, and net revenue have the highest correlations, and may thus be the best indicators of financial constraint for Canadian firms.

Hovakimian and Titman (2006), and Acharya, Almeida, and Campello (2007) find that constrained firms are less likely to pay dividends. Our results are consistent: the proportion of dividend-paying firms was twice as large in the lowest quartile of cash holdings, at 28 per cent, than in the highest quartile. By fiscal year 2005, the difference had become even more pronounced.

- **Net income:** Loss-making firms are more likely to be financially constrained and to require cash to meet day-to-day obligations, which would imply a negative relationship between net income and cash. However, loss-making firms are likely to generate less cash, so there may be a positive relationship. The data show that there is a negative relationship, with proportionally cash-rich firms more likely to be loss-making. This result is consistent with Cleary (1999), who finds that there tends to be a negative relationship between profitability and financial constraint.
- **Age:** Older firms have established reputations and are likely to have a relationship with a bank that allows them to have steady access to funding. Schaller (1993) and Hovakimian and Titman (2006) find that smaller firms are more likely to be financially constrained. Furthermore, Cooley and Quadrini (2001) and Huynh and Petrunia (2007) study financial frictions in firm size and age dynamics for U.S. and Canadian firms, respectively, and find that young firms face greater financial constraints. However, we find little difference between average- or median-age firms in the high and low cash-holdings group in our sample, perhaps because we have to proxy age rather than pick it up accurately.
- **Leverage:** Indebted firms have obviously been able to borrow at some point, so positive leverage may indicate that a firm is unconstrained. The firms with zero leverage may be the most constrained, so there may be a negative relationship between leverage and cash. Cleary (1999) finds that firms with less debt are more likely to be constrained. Our results confirm this relationship: leverage is over 26 per cent for the median firm in the bottom quartile of cash holdings, and zero for the median firm in the top quartile.
- **Cash flow:** Depending on what it signifies, cash flow may act as either a control variable or an indicator of financial constraint. There may be a positive relationship because firms that have a high cash flow may accumulate cash faster than they spend it. The relationship may be negative, as found by Cleary (1999), if those with the lowest cash flow (the weakest firms) hold cash because they are financially constrained. Our results indicate a negative relationship: firms holding the least cash had the healthiest operating cash flow relative to total assets, with a median value of 0.05, and those holding the most cash had a negative median operating cash flow ratio, of -0.02 . This may signify that financial constraint is driving these firms' cash holdings.

3.2 Sources and uses of funds

By definition, a firm's cash holdings are related to its sources and uses of funds. The following variables act largely as control variables, but may have other indicator properties.

- **Net debt and equity issuance:** Firms can obtain cash by issuing debt and/or equity, and, following a large issue, they may have elevated cash balances for some time. However,

firms that are able to issue are less likely to be financially constrained and thus may hold less cash, on average. The theoretical relationship is thus ambiguous. Firms in the highest cash quartile raised 17 per cent of their total assets through equity or debt issuance over the course of a fiscal year, compared with 4 per cent for the bottom quartile, so issuance appears to be acting as a control variable.

- **Cash-flow variability:** We take the standard deviation of industry-wide operating cash flows to total assets as a measure of cash-flow variability.¹⁷ Firms with higher cash-flow variability must hold more cash to be able to meet obligations, so there should be a positive relationship between this variable and cash. In agreement with our expectations, firms with high proportional cash holdings experienced the highest cash-flow variability by this measure, while firms in the bottom quartile had the lowest variability of cash flow.

3.3 Cost of financial constraint

Firms with more significant investment opportunities will have a higher cost of not being able to realize those opportunities. Market-to-book value and expenditure on R&D are generally accepted proxies.

- **Market-to-book value:** The literature on the cash-flow sensitivity of investment, starting with Fazzari, Hubbard, and Petersen (1988), generally treats market-to-book value as a measure of investment opportunities. Since those who have better investment opportunities have a higher cost of being financially constrained, we expect a positive relationship. This is confirmed by data: firms in the top quartile have the highest median market-to-book value, and those in the bottom quartile have the lowest.
- **R&D expense to total expense:** Those who have higher R&D expenses have better investment opportunities, but they are less able to convey these opportunities to lenders. We expect a positive relationship with cash. Our results confirm that firms with higher R&D spending accumulate more cash on their balance sheets.

Our findings are generally in line with theoretical expectations. In the highest quartile of cash holdings, firms are smaller, have lower net revenue and cash flow, have lower leverage, and are less likely to pay dividends. We thus find a positive relationship between cash holdings and our expected measures of financial constraint. Firms also have higher investment opportunities in the highest cash-holding quartile, as evidenced by the market-to-book value and R&D expense. The expected relationship also exists between the quartiles and the control variables. Our empirical results are in line with the findings of other authors in the cash-holdings literature, as shown in Table 3. Table 2 shows sample statistics for the key variables identified.

17. We did not have a consistently long-enough time series to compile firm-specific cash-flow variability.

4 Cash Holdings and Firm Characteristics: Panel Regressions

Continuing the analysis of the previous section, we attempt herein to establish a more formal link between cash holdings and firm characteristics. Following Bates, Kahle, and Stulz (2006) and Opler et al. (1999), we estimate panel regressions of a number of specifications, where the *ratio of cash and short-term investments to total assets* of the company is the dependent variable.

It is highly likely, and borne out by statistical tests, that unobserved firm heterogeneity with regards to cash holdings may be related to observable firm characteristics. Therefore, we used only fixed-effects (within-) panel methods, since they are able to deal with complications of this kind. The fixed-effects estimator gets around the problem of bias caused by the unobserved heterogeneity by measuring the effect of changes in each regressor on changes in the regressand, controlling for the unobserved individual effects.

Since firms' cash holdings could change for reasons unrelated to microeconomic characteristics, such as improvements in technology or changes in tax legislation, that affect firms throughout the economy but not uniformly across time, we estimate several specifications that include a trend, year dummies, and separate slopes for different decades. In particular, average cash ratios have been increasing over the past two decades, which could be related to observable characteristics or to factors not captured in our data.

In reported results, we filter the data to eliminate extreme outliers. In particular, we exclude the top and bottom 2 per cent according to the following characteristics: cash ratio, net working capital, capital expenditure, financial investment, leverage, and net debt and equity issuance (for definitions, please see Appendix A). This gives us 41,080 firm-years. Our qualitative results do not depend on the cut-off points. All specifications use clustered standard errors, which allow for serial correlation and heteroskedasticity within firms.

Table B1 in Appendix B illustrates the results of estimation.¹⁸ The four estimated models are as follows:

- **Model 1** is a basic model that does not include a trend or year dummies. As such, it forces the relationship between cash and firm characteristics to remain consistent over time.

18. We also tried specifications with macroeconomic variables to account for GDP growth, the ease of issuing equity (the real growth of the Toronto Stock Exchange index), and the opportunity cost of holding funds (the real prime rate). Since these variables made very little difference to our results, we present models that exclude them.

- **Model 2** is a basic model that includes a time trend, which allows it to account for firms' increasing propensity to hold cash over time.
- **Model 3** allows intercepts to differ by decade, to determine whether cash-holding behaviour has changed for reasons unrelated to firm characteristics.
- **Model 4** allows the relationship between cash holdings and firm characteristics to change over time by including different slopes and intercepts by decade. This model will tell us whether the relationship between firm characteristics and cash holdings has changed over time.¹⁹

Three aspects of our results suggest that there has been very little change in the relationship between cash holdings and firm characteristics over time. First, the models that allow for a change in the relationship (models 2–4) show little improvement over the first model in terms of fit. Second, the trend variables have very small coefficients. Third, there is only a marginal statistical difference for many of the coefficients in the fourth model, which allows for different trends by decade, compared with the first.

Judging by the relative size of the estimated coefficients and levels of significance, five variables have particular importance for the determination of cash levels: standard deviation of industry cash flows, capital expenditure relative to total assets, leverage, relative importance of R&D expense to total expenses, and net equity issuance.

Most of the coefficients have expected signs across all four specifications. For example, as the real size of a firm increases, the proportional amount of cash on its balance sheet becomes smaller. If we believe that smaller firms are more likely to be financially constrained, we would expect a negative coefficient. This result is robust across specifications, even though there is some evidence that, in the 1990s, this relationship became weaker, as the absolute value of the coefficient was cut in half.²⁰ However, in the 2000s the relationship has been restored.

According to Model 1, the standard deviation of industry cash flows has a positive coefficient, suggesting that a 10 per cent increase in the volatility of the average industry cash flow increases individual relative cash holdings by just over 2 per cent. If we believe that companies with more volatile cash flows are more likely to be financially constrained, the positive relationship between operating cash volatility and cash holdings would be expected, since firms would strive to build higher cash balances as a hedge. However, the size of the coefficient decreases

19. Separate regression for private and public firms did not produce qualitative differences.

20. This is less surprising considering that Bates, Kahle, and Stulz (2006) find that the negative relationship between cash holdings and size broke down by the 1990s.

significantly when we add trend to the equation. In fact, when we allow slopes to vary among decades, it turns out that, in the 1980s, the effect of cash-flow volatility is marginally significant but negative. However, in the 1990s, the coefficient, at 0.1,²¹ turns positive and significant. After the year 2000, the coefficient becomes even higher, increasing to about 0.15. This is likely due to rising cash volatility in the 2000s, which led to a higher proportion of companies having to increase cash holdings.

On average, firms with zero reported main revenue hold 3.5 per cent higher cash balances. While it appears that some firms normally have zero main revenue, those with zero revenue are more likely than other firms to be either very young or in financial difficulty, and therefore to have a high chance of being financially constrained. The positive sign on this coefficient is consistent with constrained firms holding more cash.

The two variables that control for cash flow have expected signs. An increase in operating cash relative to the firm-specific sample average leads to a higher cash ratio.²² The negative sign on net working capital suggests that firms that hold a smaller amount of other liquid assets hold more cash as a substitute.

As expected, capital expenditure consumes cash and leads to a lower cash ratio. For unknown reasons, capital expenditure had a stronger influence on the cash ratio in the 2000s than in either the 1980s or 1990s. This may be explained by the increased willingness of firms to use liquid assets on their balance sheets to pay for capital investment.

Leverage in the company structure has, on average, a negative effect on cash holdings. This is consistent with many constrained firms having no leverage and thus hoarding cash.

Net equity issuance has a substantial effect on cash holdings during the same year, with firms leaving part of the liquid assets they have raised on their balance sheets. A smaller proportion of money obtained from *net debt issuance* is channelled to cash on the firms' balance sheets. This may mean that firms issue debt to facilitate immediate investment, while the same is not true for equity. On average, net equity issues are much smaller than net debt issues.

It is interesting to note the significant positive effect that R&D expenditure has on cash holdings. For every 10 per cent increase in relative importance of R&D spending in total expenses, the cash ratio increases by between 2.6 per cent and 3.7 per cent. Intuitively, since R&D benefits are

21. That is, 0.224 minus 0.123, the sum of the base and 1990s coefficients.

22. Note, however, that Table 2 shows that firms with higher cash ratios have lower *average* operating cash.

uncertain and hard to verify by financial intermediaries, the informational frictions are likely to be higher for firms that are more actively engaged in research; such firms are more likely to be financially constrained, leading to stockpiling of cash. Moreover, if R&D produces valuable investment opportunities, the cost of being financially constrained is higher for these firms.

Two variables have unexpected signs. The first is the dividend dummy. We expect to find a negative relationship between cash holdings and dividends, because firms that pay dividends will accumulate less cash and constrained firms are less likely to pay dividends. We obtain a positive but insignificant relationship for most models and time periods. The second variable that has an unexpected sign is the negative equity dummy, which takes a value of one when the firm's liabilities are greater than its assets. If financially distressed firms are hoarding cash, we would expect this variable to have a positive sign. However, we may be picking up the fact that distressed firms are likely to have trouble accumulating cash.²³

Two variables that we discussed in earlier parts of the paper have been omitted. First, the age of a firm cannot be included, because of the high multicollinearity with the trend variable. Second, market-to-book value is available only for firms that are listed on the stock exchange. If we had included this variable, we would have significantly reduced the number of firms and limited the sample to firms that are arguably less financially constrained, since they have access to financial markets.

In summary, the results indicate that firms that are more likely to be financially constrained, as evidenced by size, leverage, cash-flow variability, and non-positive sales, accumulate more cash. Furthermore, firms with a higher cost of financial constraint, as evidenced by expenditure on R&D, hold a higher cash ratio.

5 Cross-Sectional Regressions and Out-of-Sample Forecasts

In this section, we estimate cross-sectional regressions for each year between 1980 and 1989, and use average coefficients to predict cash holdings for firms in the 1990s and 2000s. This will shed light on whether the increase in cash is above what would be predicted based on changes in firm characteristics since the 1980s. Persistently high/low errors in the 1990s and 2000s would demonstrate that either there has been an exogenous change in the relationship between firm characteristics and cash holdings since the 1980s, or that other excluded factors led to persistently different holdings of cash. Furthermore, if prediction errors are different among

23. This may also be due to the fixed-effects set-up, which is only able to estimate the coefficients on variables that change during the sample.

firms grouped according to the degree of financial constraint, it may be an indication that the relationship between firm characteristics and cash holdings has changed for one particular group. For simplicity, we use dividend payment policy and membership in the TSE300 index as indicators of financial constraint.

Table B2 in Appendix B lists average estimated coefficients for the 1980s model that are generally close to the ones obtained from the panel regressions. Average errors of prediction, listed in Table B3, are also shown according to the split between dividend paying and non-paying firms, as well as between members and non-members of the TSE300 index (Table B4).

The periods of interest are 1990–2007 and 2000–07, the former roughly corresponding to the inflation-targeting period, and the latter encompassing the years of rapid financial innovation and excluding the sustained boom in equity markets in the 1990s. In general, we find that the 1980s model predicts that firms would hold only slightly less cash than they actually do. Since the model underpredicts cash holdings by only around 2 per cent, the increase in cash holdings can be almost entirely attributed to changes in firm characteristics, rather than to an exogenous change in how firms utilize cash.

The cross-sectional findings are also consistent with results obtained in the previous section. First, dividend-paying firms had lower cash ratios than we would have predicted on the basis of cross-sectional regressions. For the non-paying firms the results are the opposite. Moreover, since the dividend dummy is included in the cross-sectional regressions, the difference between non-dividend-paying and dividend-paying firms is due to the divergence in behaviour that is particular to 1990–2007.

Members of the TSE300 index accumulated cash above the predicted levels to the same extent in 1990–2007, suggesting that firm behaviour has changed to the same degree in the two groups.

It is also interesting to note that average predicted errors increased noticeably in the 2003–06 period compared with the earlier period. This may suggest one of at least three things: (i) firms have been operating more conservatively in recent years and this has led them to hold more cash, (ii) the extreme volatility of cash flows experienced in the 2000s had a threshold effect on cash accumulation, or (iii) the increase in the number of income trusts in Canada is having an influence on cash.²⁴

24. Unfortunately, our data set does not indicate which firms are income trusts, so we cannot test this hypothesis directly.

6 Conclusions

When capital markets are imperfect, the costs of internally generated and external funds are no longer equal, and, depending on their individual characteristics, each firm will have a desired level of cash holdings. This desired level is likely to be higher for financially constrained firms, since cash holdings will allow these firms to continue operations and pursue profitable investment opportunities when they are unable to obtain capital.

The average of individual firms' cash holdings has increased substantially in the past 15 years; we are interested in whether this was driven by changes in the characteristics of the average firm, especially as they relate to financial constraint. In this paper, we have employed a firm-level data set covering Canadian non-financial firms from 1980–2006 and found that almost the entire increase in cash holdings can be explained by changes in firm characteristics. Specifically, the factors that explain higher cash holdings are an increase in the number of firms that appear to be financially distressed, cash-flow variability, expenditure on R&D, a decrease in size, and the use of cash substitutes by the average Canadian firm. Smaller and distressed firms are likely to be financially constrained, and firms that have high expenditure on R&D generally have a higher cost of being financially constrained, as well as a higher need for external funding. It is interesting to note, however, that dividend payment is not a significant determinant of cash holdings for Canada, whereas it is significant in most studies for other countries.

We find very little evidence that the influence of firm characteristics on cash-holding behaviour changed between the 1980s and 1990s–2000s, with only a few coefficients changing appreciably over time. First, a model that allows the relationship between firm characteristics and cash to vary by decade does little better than our base model in explaining firms' cash holdings, and few coefficients change significantly. Second, a model based on the demand for cash in the 1980s and used to predict cash holdings in the 1990s and 2000s reveals that actual cash holdings are only marginally above predicted values. This implies that Canadian firms are, on average, holding more cash because their characteristics have changed, rather than imply an exogenous change in firms' demand for cash. This result is consistent with that of Bates, Kahle, and Stulz (2006) for U.S. firms.

Transformations that have occurred in the economy within the past twenty years, particularly in its industrial composition, have affected the behaviour of aggregate series, of which liquid balances is one example. An observer that neglected to investigate the underlying causes of this altered behaviour could conclude that an increase in cash holdings by firms was “abnormal” to

some extent. However, as we have shown, liquid balances are, in large part, determined by firm characteristics, and there is little evidence of “excess” liquid holdings in the economy.

Theory tells us that investment by financially constrained firms should be more sensitive to cash flow than that by unconstrained firms, and our results tell us that financial constraints are important for cash-holding behaviour. It would thus be useful to update the analysis of Schaller (1993) and Chirinko and Schaller (1995) to determine whether the cash-flow sensitivity of investment is higher for constrained Canadian firms. Doing so may improve our abilities to understand financial constraints and forecast investment.

References

- Acharya, V., H. Almeida, and M. Campello. 2007. "Is Cash Negative Debt? A Hedging Perspective on Corporate Financial Policies." *Journal of Financial Intermediation* 16 (4): 515–54.
- Almeida, H., M. Campello, and M. S. Weisbach. 2004. "The Cash Flow Sensitivity of Cash." *Journal of Finance* 59 (4): 1777–1804.
- Anderson, S. 2006. "Recent Developments in the Income Trust Market." Bank of Canada *Financial System Review* (June): 22–26.
- Bates, T. W., K. M. Kahle, and R. M. Stulz. 2006. "Why Do U.S. Firms Hold So Much More Cash Than They Used To?" NBER Working Paper No. 12534; forthcoming in *Journal of Finance*.
- Baum, C. F. and C. F. Thies. 1999. "Q, Cash Flow and Investment: An Econometric Critique." *Review of Quantitative Finance and Accounting* 12 (1): 35–47.
- Canada. Department of Finance. 2006. "Draft Changes to Eliminate the Double Taxation of Large Corporation Dividends." (June). Available at <http://www.fin.gc.ca/news06/06-028e.html>.
- Chirinko, R. S. and H. Schaller. 1995. "Why Does Liquidity Matter in Investment Equations?" *Journal of Money, Credit and Banking* 27 (2): 527–48.
- Cleary, S. 1999. "The Relationship between Firm Investment and Financial Status." *Journal of Finance* 54 (2): 673–92.
- Cooley, T. F. and V. Quadrini. 2001. "Financial Markets and Firm Dynamics." *American Economic Review* 91 (5): 1286–1310.
- Couderc, N. 2005. "Corporate Cash Holdings: Financial Determinants and Consequences." Unpublished manuscript.
- Davydenko, S. A. 2007. "When Do Firms Default? A Study of the Default Boundary." Unpublished manuscript. Available at <http://www.rotman.utoronto.ca/davydenko>.
- Dittmar, A., J. Mahrt-Smith, and H. Servaes. 2003. "International Corporate Governance and Corporate Cash Holdings." *Journal of Financial and Quantitative Analysis* 38 (1): 111–33.
- Fama, E. F. and K. R. French. 2001. "Disappearing Dividends: Changing Firm Characteristics or Lower Propensity to Pay?" *Journal of Financial Economics* 60 (1): 3–43.
- Fazzari, S. M., R. G. Hubbard, and B. C. Petersen. 1988. "Financing Constraints and Corporate Investment." *Brookings Papers on Economic Activity* 1: 141–206.

- Hoshi, T., A. Kashyap, and D. Scharfstein. 1991. "Corporate Structure, Liquidity, and Investment: Evidence from Japanese Industrial Groups." *Quarterly Journal of Economics* 106 (1): 33–60.
- Hovakimian, G. and S. Titman. 2006. "Corporate Investment with Financial Constraints: Sensitivity of Investment to Funds from Voluntary Asset Sales." *Journal of Money, Credit and Banking* 38 (2): 357–74.
- Huynh, K. P. and R. J. Petrunia. 2007. "Firm Size Dynamics: Age Effects and Financial Frictions." Unpublished manuscript dated 7 August.
- Kaplan, S. N. and L. Zingales. 1997. "Do Investment-Cash Flow Sensitivities Provide Useful Measures of Financing Constraints." *Quarterly Journal of Economics* 112 (1): 169–215.
- Kim, C-S., D. C. Mauer, and A. E. Sherman. 1998. "The Determinants of Corporate Liquidity: Theory and Evidence." *Journal of Financial and Quantitative Analysis* 33 (3): 335–59.
- McKenzie, K. J. and A. J. Thompson. 1995. "Dividend Taxation and Equity Value: The Canadian Tax Changes of 1986." *Canadian Journal of Economics* 28 (2): 463–72.
- Opler, T., L. Pinkowitz, R. Stulz, and R. Williamson. 1999. "The Determinants and Implications of Corporate Cash Holdings." *Journal of Financial Economics* 52 (1): 3–46.
- Schaller, H. 1993. "Asymmetric Information, Liquidity Constraints and Canadian Investment." *Canadian Journal of Economics* 26 (3): 552–74.
- Whited, T. M. and G. Wu. 2006. "Financial Constraints Risk." *Review of Financial Studies* 19 (2): 531–59.

Table 1
Ratio of Liquid Assets to Total Assets for Selected Industries

	1980–2006 Average (per cent)	2000–06 Average (per cent)	2006 (per cent)
Agriculture	3.62	2.22	4.08
Automotive	9.98	15.90	14.17
Biotechnology and pharmaceutical	38.19	40.88	46.56
Cable	4.49	4.00	1.18
Chemicals	5.92	8.62	5.55
Computer software and processing	24.27	29.32	29.32
Consulting	15.47	13.65	15.29
Contractors	12.50	16.78	16.16
Department stores	4.35	5.52	9.84
East Coast forestry	5.70	4.58	5.31
Electrical and electronic	18.46	26.92	27.26
Entertainment services	11.12	10.83	8.65
Food processing	5.59	5.32	4.82
Food stores	5.89	7.08	5.73
Gas pipelines	6.68	1.07	1.16
Integrated mines	12.35	13.91	20.01
Integrated oils	5.48	8.75	4.95
Management and diversified	10.79	15.18	17.62
Metal mines	16.86	19.83	24.33
Misc. industrial products	13.96	17.44	14.99
Oil and gas field services	8.79	7.51	4.72
Oil and gas producers	11.91	14.74	13.64
Oil pipelines	3.45	1.13	0.69
Other mines	18.09	20.98	21.70
Other services	17.46	19.92	20.62
Precious metals	19.98	22.83	27.54
Specialty stores	9.20	11.19	15.53
Steel	4.54	4.95	6.49
Telecommunications	15.12	17.21	17.19
Transportation	7.32	6.92	6.62
Transportation equip & components	9.87	14.20	14.59
West Coast forestry	3.77	6.48	10.82
Wholesale distributors	4.89	4.52	2.04

Note: These industries accounted for more than 90% of both total and liquid assets in the database and just over 88% of total firms in both 2004 and 2005.

Table 2
Median Values of Selected Variables for Quartiles of Cash Holdings

	Lowest quartile	Two middle quartiles	Highest quartile
Real size	\$31,459,103	\$18,958,989	\$8,722,623
Dividends*	0.28	0.26	0.15
Net income	\$70,247	\$-117,987	\$-210,798
Age	6	7	6
Leverage	0.27	0.13	0.00
Operating cash to total assets	0.05	0.02	-0.02
Cash raised through net debt and equity	0.04	0.07	0.17
Cash-flow variability	0.07	0.08	0.13
Market-to-book-value ratio	1.23	1.39	2.19
R&D/Total expense **	0.4%	1.1%	5.4%

* The proportion of firms that pay dividends is shown.

** The mean of this variable is shown, because the median is zero.

Table 3
Relationship between Cash Holdings and Financial Constraints: Comparison of
Our Empirical Findings with those of Other Researchers

Variable	Results					
	This paper ¹	Opler et al. (1999) ¹	Couderc (2005)		Bates, Kahle, and Stulz (2006) ¹	Kim, Mauer, and Sherman (1998)
	Canada	U.S.	Canada	Overall	U.S.	U.S.
Size	-/s	-/s	-/i	-/s	-/s	-/i
Leverage	-/s	-/s	-/s	-/s	-/s	-/s
Dividend payout	+/i	+/s	+/i	-/i	-/s	n/a
Cash flow	+/s	+/s	-/i	+/s	-/s	-/s
Cash-flow variability	+/s	-/s	+/i	+/i	+/s	+/s
Investment opportunities	n/a	+/s	+/s	+/s	+/s	+/s
R&D expense	+/s	+/s	n/a	n/a	+/s	n/a
Substitutes for cash	-/s	-/s	n/a	n/a	-/s	n/a

Note: “s” denotes significant at the 10% level or better, and “i” denotes insignificant.
1. Base panel fixed-effects models. In some cases, the findings apply to other models.

Chart 1
Cash, Gross, and Net Leverage

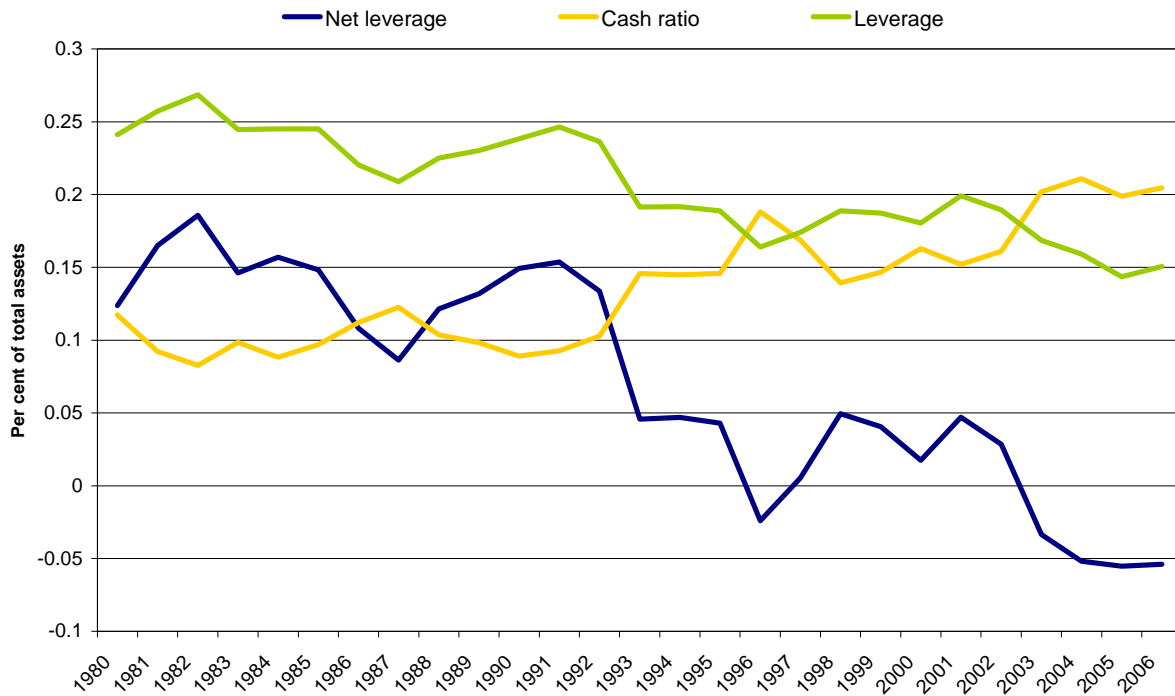


Chart 2
Key Current Assets as a Share of Total Assets

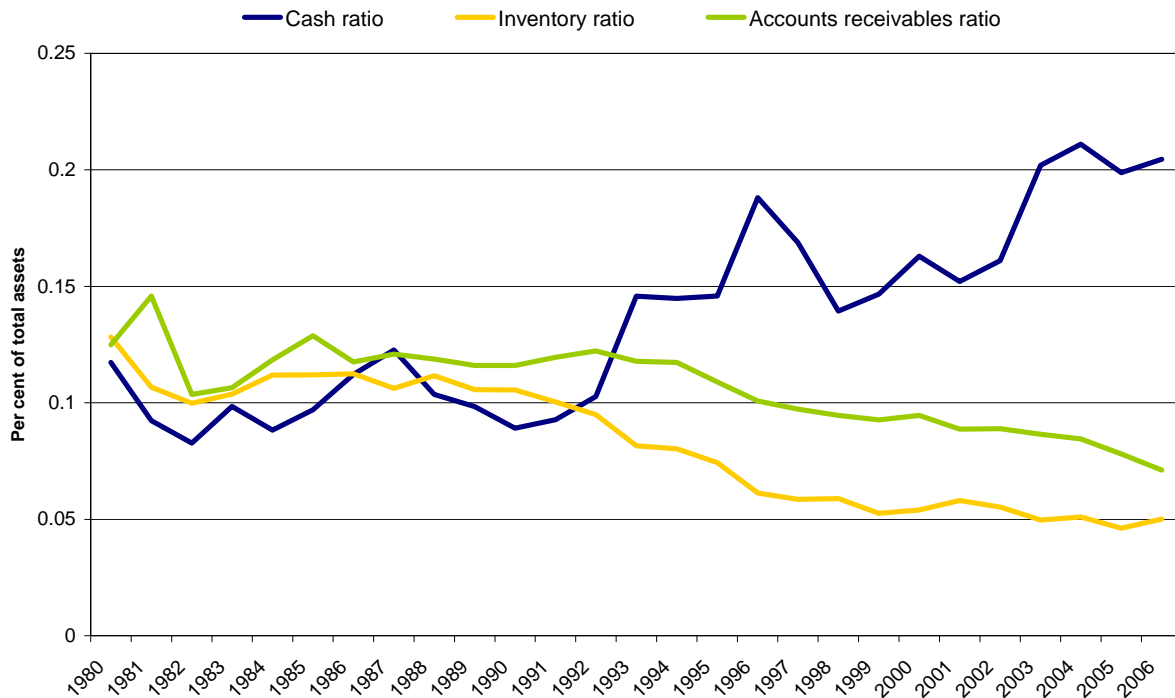


Chart 3
Net Working Capital Ratios

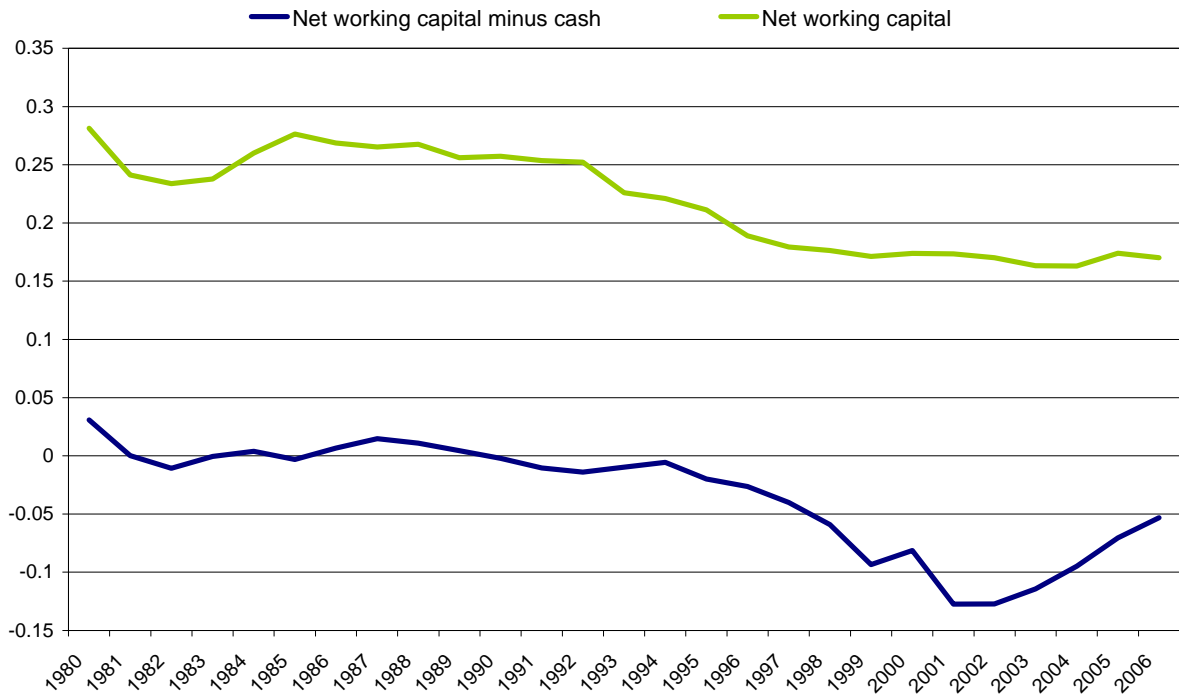


Chart 4
Average Size and Age of Firms

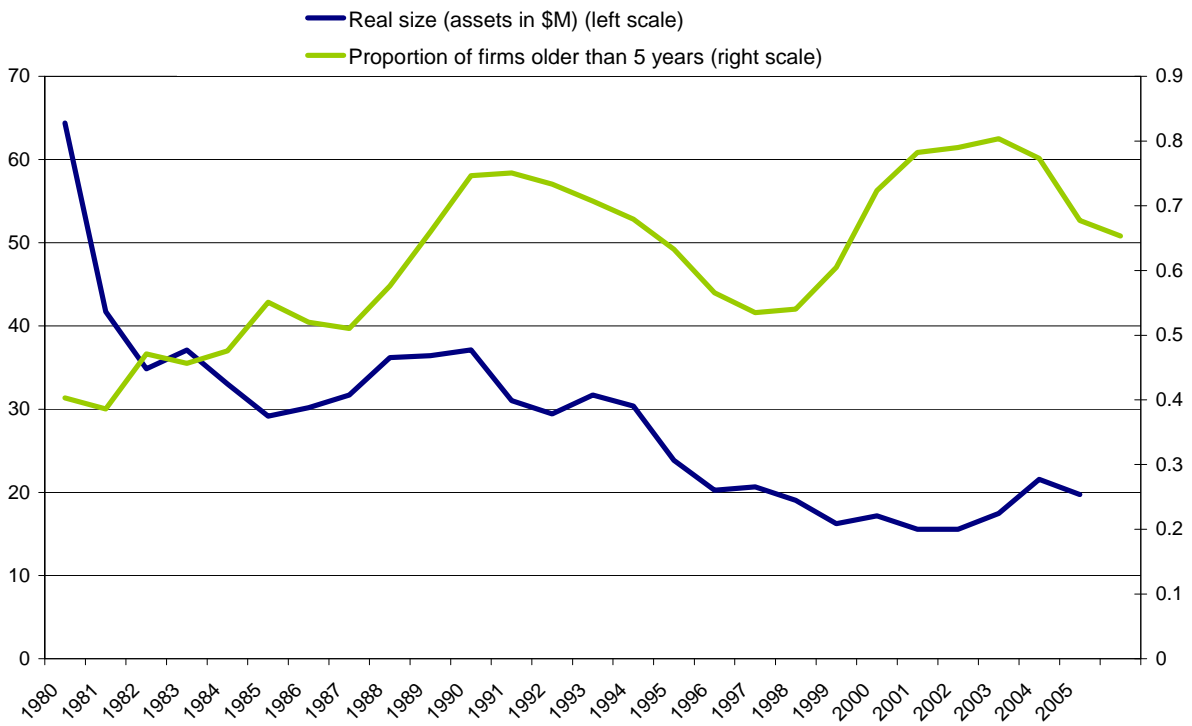


Chart 5
Percentage of Firms Paying Dividends

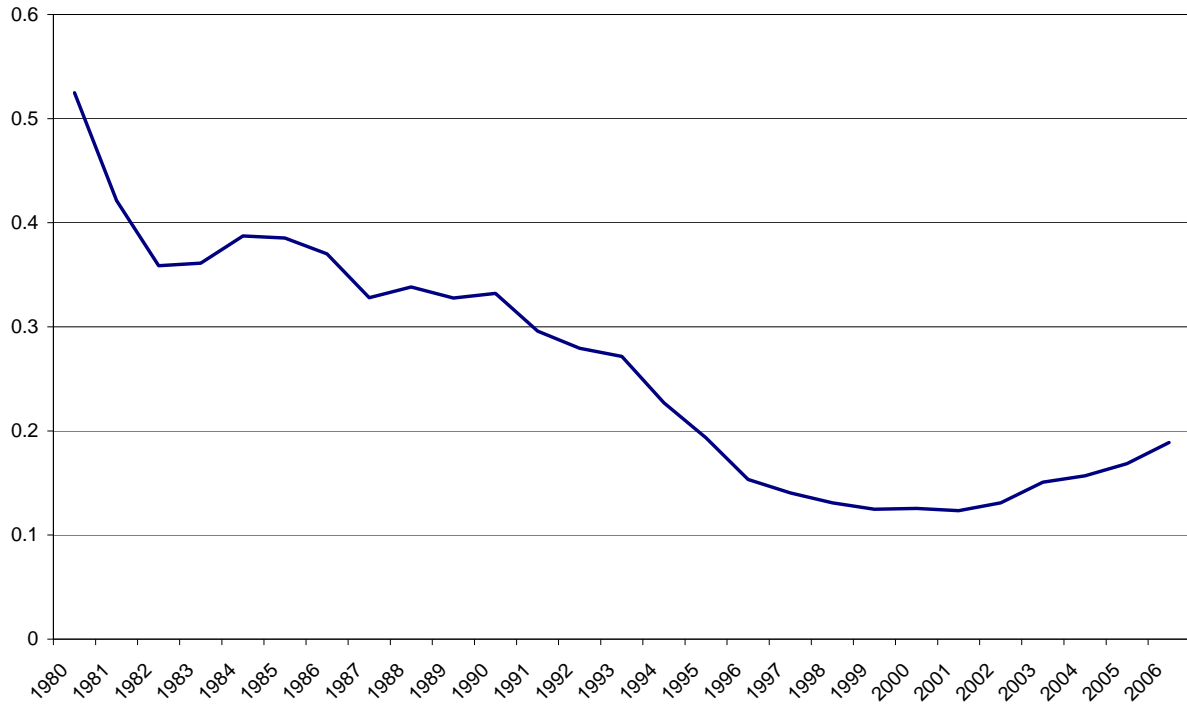


Chart 6
Measures of Distress

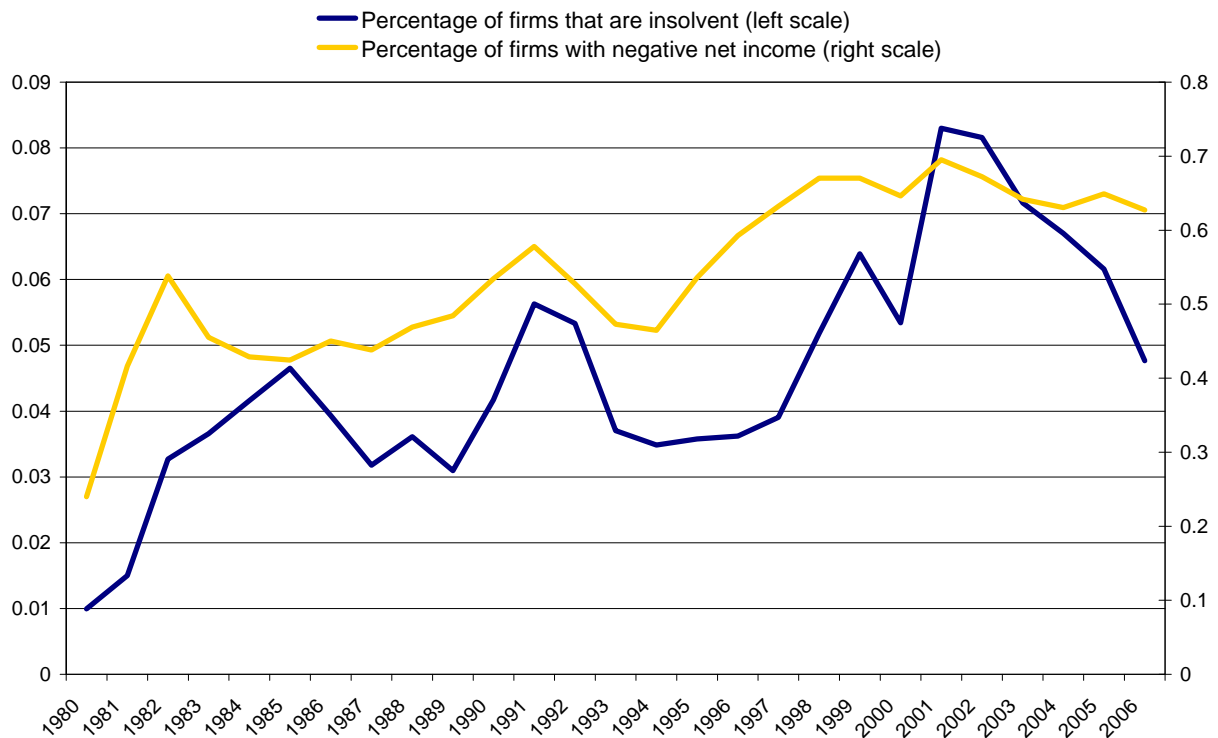


Chart 7
R&D Expense/Total Expense

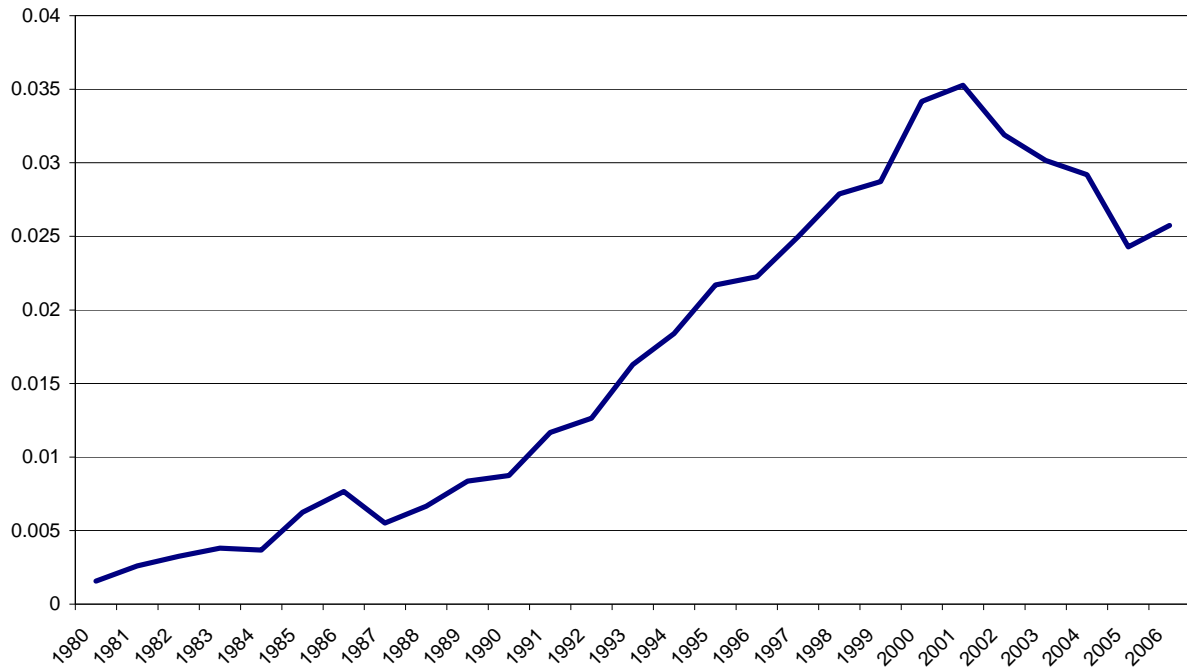


Chart 8
Market-to-Book Value and Capital Expenditures

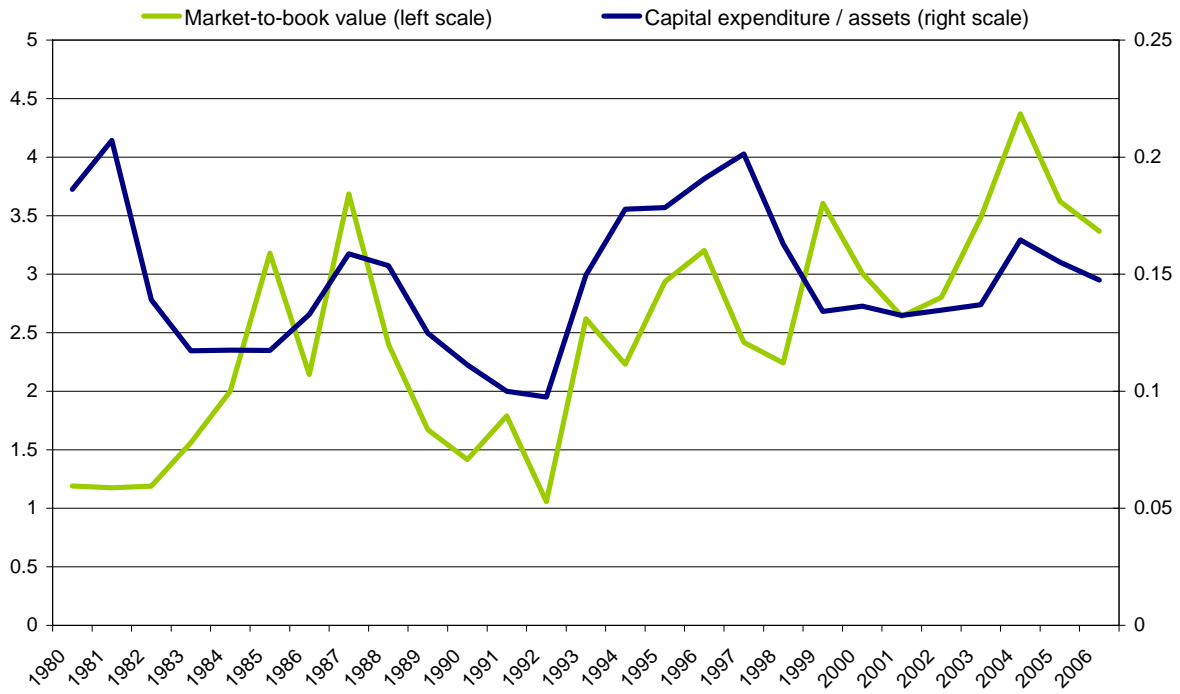


Chart 9
Cash-Flow Variability

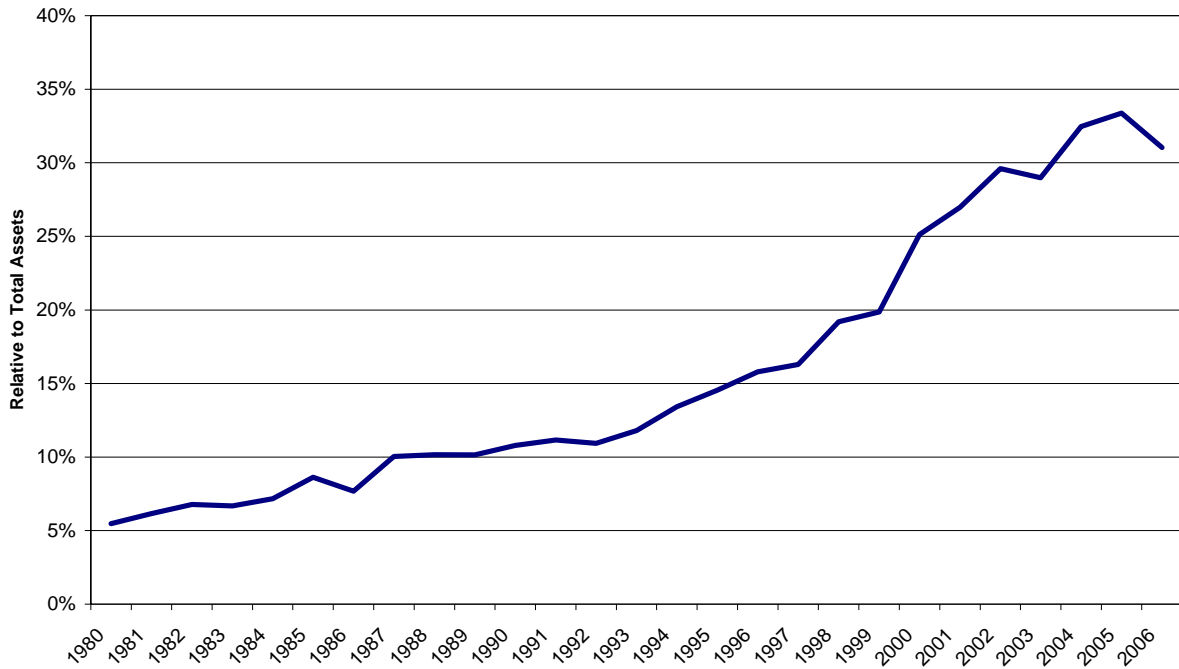


Chart 10
Net Proceeds of Issuance

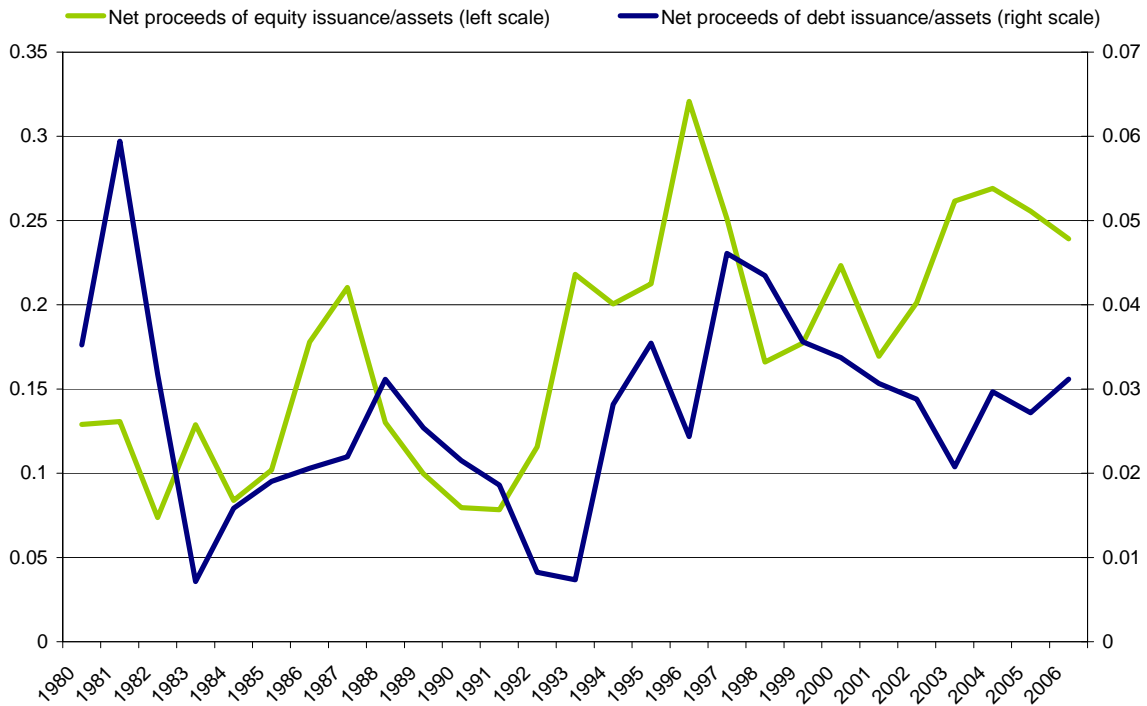
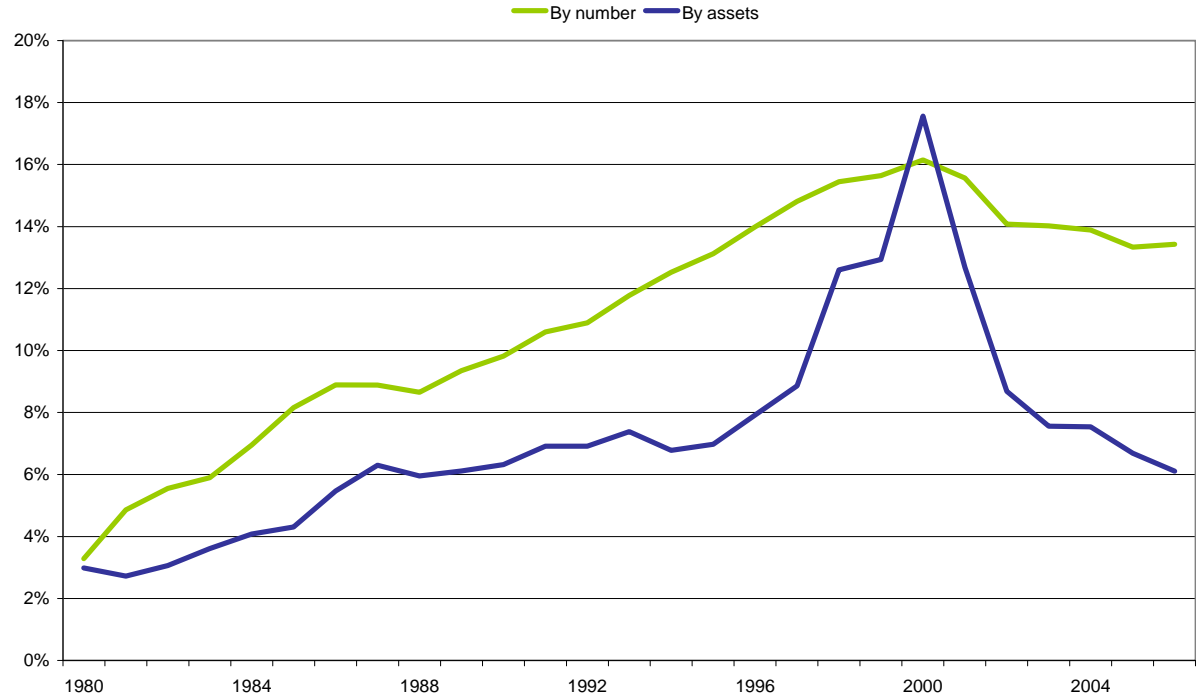


Chart 11
Knowledge-Based Industries' Share of Total Economy



Note: Biotechnology, computer software and processing, electrical and electronic, and telecommunications are included here.

Appendix A: Variable Definitions

All firm-specific data are from the *Globe and Mail Report on Business* database and macroeconomic data are from Statistics Canada's ETS databases. Actual variable mnemonics are in parentheses.

Report on Business database variables

Standard deviation of industry operating cash flow: average standard deviation of the ratio of operating cash flow to total assets for up to ten years, across firms with at least three years of data (standard deviation*(factor(WCOPER))/TOTLAS).

Real size: real assets are in 2005 constant dollars (TOTLAS/v41690973).

Ratio of operating cash to total assets: working capital from operations from the cash-flow statement divided by the book value of assets (WCOPER/TOTLAS).

Net working capital: a ratio of the current assets net of cash and current liabilities to total assets ((CTOTAS-CSHINV-CTOTLI)/TOTLAS).

Capital expenditure: cash spent on fixed-asset acquisition divided by total assets (ACQFIX+FIXSUB)/TOTLAS.

Investment in financial assets: funds spent on increasing investments and advances divided by the book value of assets (INCINV/TOTLAS).

Leverage: a ratio of total debt at book value to the total book value of assets ((BANKIN+DBTADV+CURLTD)/TOTLAS).

Net leverage is the ratio of total debt less cash to the total book value of assets ((BANKIN+DBTADV+CURLTD-CSHINV)/(TOTLAS-CSHINV)).

Research and development: expenditure on research and development divided by total expense (RSADEV/TOTEXP).

Market-to-book value: the market value of the firm based on its stock outstanding divided by its book value, and divided by total assets (COMOTS*MKPRCL+TOTLAS-COMSTK-RETEAR*COMSTK/(TOTSHE-RETEAR))/TOTLAS.

Dividend dummy: 1 if a firm paid dividends that year (DIVTOT).

Net equity issuance: issuance of new equity net of repurchases/repayments divided by the total assets ((factor*(SALSTK-REPSTK))/TOTLAS).

Net debt issuance: issuance of new debt net of repurchases/repayments divided by the total assets ((factor*(INCDBT-REDDBT))/TOTLAS).

Total sales=0 dummy: 1 in years when total sales are zero (TSALES).

Negative equity dummy: 1 when equity is negative in a given year (TOTLIA>TOTLAS).

Loss dummy: 1 when net income is negative in a given year (NETINC).

Slope coefficients for the 1990s and 2000s are additive to the base coefficients. For example, for 2001 the coefficient on real size would be the base coefficient plus the coefficient for the 2000s.

Consumer price index (CPI) 2005 basket - Canada; All-items (ETSCPI series V41690973).

Appendix B: Empirical Results

While the information in the *Globe and Mail Report on Business* database is generally of good quality, data for a subset of firms are questionable, with flow-to-stock ratios being unreasonably high or low. Therefore, we exclude firms whose ratios of cash, net working capital, capital expenditure, financial investment, leverage, and net equity and debt issuance to total firm assets fall in the lower or upper 2 per cent tail. Even though over 7,000 observations are discarded in this way for the 1980–2005 period, 15 per cent of the full sample, the results of the estimation are, in general, robust to the choice of cut-off point.

Table B1
Panel Regressions Using Fixed Effects: Results of Empirical Models

The dependent variable for all regressions is (cash and short-term investments)/total assets.

	Model 1		Model 2		Model 3		Model 4*					
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Base		1990s		2000s	
	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value	Coefficient	p-value
Industry cash-flow standard deviation	0.216	(0.000)	0.132	(0.000)	0.135	(0.000)	-0.123	(0.088)	0.224	(0.004)	0.276	(0.000)
Real size	-0.004	(0.009)	-0.006	(0.000)	-0.009	(0.000)	-0.010	(0.000)	0.004	(0.011)	0.000	(0.972)
Operating cash ratio	0.036	(0.000)	0.038	(0.000)	0.036	(0.000)	0.075	(0.000)	-0.039	(0.083)	-0.045	(0.041)
Net working capital	-0.052	(0.000)	-0.049	(0.000)	-0.050	(0.000)	-0.092	(0.000)	0.043	(0.004)	0.053	(0.001)
Capital expenditure	-0.189	(0.000)	-0.187	(0.000)	-0.195	(0.000)	-0.180	(0.000)	0.003	(0.860)	-0.053	(0.004)
Investment in financial assets	0.019	(0.193)	0.020	(0.172)	0.017	(0.239)	-0.139	(0.000)	0.111	(0.000)	0.289	(0.000)
Leverage	-0.143	(0.000)	-0.141	(0.000)	-0.134	(0.000)	-0.146	(0.000)	-0.010	(0.437)	0.037	(0.026)
R&D to total expenses	0.354	(0.000)	0.355	(0.000)	0.366	(0.000)	0.260	(0.021)	0.087	(0.425)	0.107	(0.358)
Dividend dummy	0.001	(0.797)	0.002	(0.529)	0.001	(0.725)	0.010	(0.027)	-0.015	(0.011)	-0.012	(0.148)
Net equity issuance	0.180	(0.000)	0.180	(0.000)	0.175	(0.000)	0.153	(0.000)	0.012	(0.396)	0.043	(0.004)
Net debt issuance	0.074	(0.000)	0.075	(0.000)	0.071	(0.000)	0.109	(0.000)	-0.029	(0.112)	-0.053	(0.018)
Total sales = 0 dummy	0.035	(0.000)	0.033	(0.000)	0.035	(0.000)	0.048	(0.000)	-0.019	(0.061)	-0.016	(0.172)
Negative equity dummy	-0.017	(0.016)	-0.020	(0.006)	-0.023	(0.001)	-0.003	(0.778)	-0.003	(0.853)	-0.042	(0.007)
Trend			0.001	(0.000)	0.003	(0.005)	0.002	(0.247)				
Constant	0.191	(0.000)	0.215	(0.000)	0.289	(0.000)	0.335	(0.000)				
yr90s					-0.069	(0.000)						
year dummies	NO		NO		YES		YES					
Adjusted R ²	within	0.17	within	0.17	within	0.18	within	0.19				
	between	0.36	between	0.36	between	0.35	between	0.35				
	overall	0.29	overall	0.29	overall	0.29	overall	0.30				

* In model 4, coefficients on the 1990s and 2000s are the base coefficient plus that of the 1990s or 2000s.

Cross-Sectional Regressions

Coefficients are the average of cross-sectional regressions estimated for each year between 1980 and 1989. The dependent variable is (cash and short-term investments)/total assets.

Table B2
Average Coefficients from 1980s Cross-Sectional Regressions

Industry cash flow standard deviation	0.120987
Real assets	-0.00799
Operating cash ratio	0.072506
Net working capital	-0.06313
Capital expenditure	-0.13472
Investment in financial assets	-0.08698
Leverage	-0.18107
R&D to total expenses	0.407954
Dividend dummy	0.003423
Net equity issuance	0.073003
Net debt issuance	0.090622
Total sales = 0 dummy	0.04665
Negative equity dummy	0.016366
Constant	0.274715

Table B3
Actual and Predicted Cash Holdings from the 1980s Model

Fiscal Year	Actual	Predicted	Error
1980	0.117	0.091	0.027
1981	0.092	0.089	0.003
1982	0.083	0.092	-0.009
1983	0.098	0.101	-0.002
1984	0.088	0.101	-0.012
1985	0.097	0.108	-0.011
1986	0.112	0.115	-0.003
1987	0.123	0.118	0.005
1988	0.104	0.111	-0.007
1989	0.098	0.112	-0.013
1990	0.089	0.112	-0.023
1991	0.093	0.115	-0.022
1992	0.103	0.121	-0.018
1993	0.146	0.132	0.014
1994	0.145	0.131	0.014
1995	0.146	0.140	0.006
1996	0.188	0.153	0.036
1997	0.169	0.148	0.021
1998	0.139	0.149	-0.009
1999	0.147	0.157	-0.011
2000	0.163	0.167	-0.004
2001	0.152	0.164	-0.012
2002	0.161	0.172	-0.011
2003	0.202	0.179	0.023
2004	0.211	0.178	0.033
2005	0.199	0.180	0.019
2006	0.205	0.172	0.033

Table B4**Forecast-Error Determinants for Constrained and Unconstrained Firms**

Average errors from cross-sectional regressions estimated for each year between 1980 and 1989 that are divided according to whether a firm pays dividends and is a member of the TSE300. The dependent variable is (cash and short-term investments)/total assets.

	Average forecast error	Pays dividends			TSE300 member		
		Yes	No	Difference p -value	Yes	No	Difference p -value
1990–2007	0.008	-0.006	0.011	0.00	0.010	0.004	0.020
2000–2007	0.013	-0.016	0.019	0.00	0.014	0.010	0.400