Advanced Corporate Finance (6314M0277Y)

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MSc Finance

Group Assignment 1

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Step #1. Testing Theories of Corporate Investment

a)

Financially constrained firms generally indicate the corporations which face the difficulty of external financing and more reliance on internal cashflows, ending up with passing up desired investment opportunities even if the Tobin's Q is high.

Accordingly, the Financial Constraints Theory implies the positive relationship between cashflows and investments(or cash holdings) for financially constrained firms. This idea was built up early by Fazzari et al. (1988) showing that the corporate investment depends on availability of internal financing. Financial constraint can be relevant to many factors such as firm age and firm type. As discussed in the lecture, young firms are more likely to be financially constrained due to the lack of cash and low profitability while mature firms might also have trouble with external funding due to large initial investment costs. In addition, recent research indicates that especially innovative firms such as pharmaceutical and software development companies are more likely to face the problem of getting financially constrained. Because they create a large amount of intangible assets which are poor collateral when financing externally. Hence, they have to hold more cash to do R&D investments and retain talents.

In this case, we use *Cashflows/Book Value of Assets* to measure the degree of financial constraint of sample firms. Firstly, we calculate the mean value of variable *Cashflows/Book Value of Assets*. If a firm's level of *Cashflows/Book Value of Assets* is higher than the average, then it is categorized as a non-financially-constrained firm. Conversely, firms with lower-than-average level of *Cashflows/Book Value of Assets* are considered as those with financial constraints. This condition will be used in one of our regression models as well.

b)

For Q Theory:

Null Hypothesis (H_0): Tobin's Q does not affect the investment behaviour of a firm.

Alternative Hypothesis (H_1): Tobin's Q positively affects the investment behaviour of a firm.

For Financial Constraints Theory:

Null Hypothesis (H_0): Cashflows do not affect the investment behaviour of a firm.

Alternative Hypothesis (H_1): Cashflows positively affect investment behaviour of a firm.

To test both the Q Theory and Financial Constraint Theory simultaneously, we initially formed following regression:

$$Y_{i,t} = \beta_0 + \beta_1 \cdot tq\_lag_{i,t} + \quad \beta_2 \cdot cashflows\_assets_{i,t} + u$$

where dependent variable $Y_{i,t}$ is the investment behavior (total investment) of the sample firm i at year t, estimated by *capital expenditure (tangible investment)* + *R&D investment (intangible investment)*. Key explanatory variable tq_i refers to the lagged Tobin's Q (Tobin's Q in year *t-1*) which is calculated by market value of firms (computed by *market capitalization* + *long term debt* + *short term debt*) divided by replacement cost of capital (book value of assets as proxy in this case). The other key explanatory variable $cashflows\_assets_{i,t}$ represents the variable capturing the degree of firm i's financial constraint and is determined by *cashflows/book value of assets*. Additionally, u means the error term in this regression.

To provide robust outcomes, we winsorize the variables to get rid of the outliers. The outcomes of this regression are displayed in the Model 1 of Table 1:

$$w\_Y_{i,t} = \beta_0 + \beta_1 \cdot w\_tq\_lag_{i,t} + \quad \beta_2 \cdot w\_cashflows\_assets_{i,t} + u$$

Besides, similar to previous literatures, we also add dummy variables such as firm-size dummy and financial-constraint dummy in our regression. The outputs are displayed in Table A.1 and Table A.2.

c)

The following table summarizes the outcomes of our regression. In this table, Model 1 displays the regression output for the sample firms from 1970 to 2015 (the whole time span);

Model 2 shows the regression result from 1970 till 1990 (1990 is not included); Model 3 reviews the regression outcome from 1990 till 2015.

	(1) **Model 1**	(2) **Model 2**	(3) **Model 3**
w_tq_lag	0.0238*** (29.07)	0.0215*** (17.82)	0.0236*** (24.85)
w_cashflows_assets	-0.0036 (-0.48)	0.1789*** (14.37)	-0.0437*** (-5.32)
_cons	0.0682*** 53.64)	0.0571*** (37.32)	0.0680*** (38.12)
N	80584	39045	41539
R^2	0.1140	0.1278	0.1271

t statistics in parentheses
** p<0.05, ** p<0.01, *** p<0.001*

Table 1: Regression Model Outputs

According to the table, the constant (β_0) of Model 1 is 0.0682 which indicates that the mean value of 'investment/book value of assets' is expected to be around 6.82% when the value of other variables are 0. By comparing the constants in Model 2 (0.0571) and Model 3 (0.068), we can find that the average investment of corporations after 1990 is higher than the value before 1990. Turning to the Tobin's Q, if Q increases by 1 unit, ceteris paribus, the dependent variable is expected to increase by 0.0238 units (2.38 percentage points) on average in Model1. In addition, the coefficients of Tobin's Q in these 3 models are similar, which are also statistically significant for regular confidence levels (90%, 95%, 99%). Moreover, the coefficients of regressor 'cashflows_assets' are noticeable. In Model 1, the output is not statistically significant which means that this variable does not have strong explanatory power to the dependent variable. In Model 2, the cashflows significantly predict the investment: ceteris paribus, every extra unit of 'w_cashflows_assets' would increase the dependent variable by 0.1789 on average. Nevertheless, this coefficient in Model 3 becomes negative: every extra unit of regressor would decrease the dependent variable by 0.0437 units on average. This can be attributed to the fact that after the year 1990, more firms use the cashflows as the precautionary savings in order to continuously invest during the downturn of the economy. The outputs of β_2 in both Model 2 and Model 3 are statistically significant. Furthermore, the R^2 of these 3 models are respectively 11.40%, 12.78% and 12.71%, which is for determining the explanatory power of listed regressors.

In conclusion, the null hypothesis of Tobin's Q theory can be rejected on the confidence level of at least 99%. However, for financial constraint theory, it depends. According to the Model 2 and Model 3, the null hypothesis of financial constraint theory can be rejected on the 99% confidence level.

d)

For firms which are already financially constrained, their cashflows are more likely to decrease to a lower level during the recession, leading to more negative outcomes. Due to the lack of cashflows, firms might be inclined to use equity instead of using internal cash, which can be considered as a bad signal of firms' situations. Therefore, a forward-looking manager is supposed to retain more cash in good states which in this case refer to the period before recessions. This can further reduce the likelihood of getting more constrained in the future recessions.

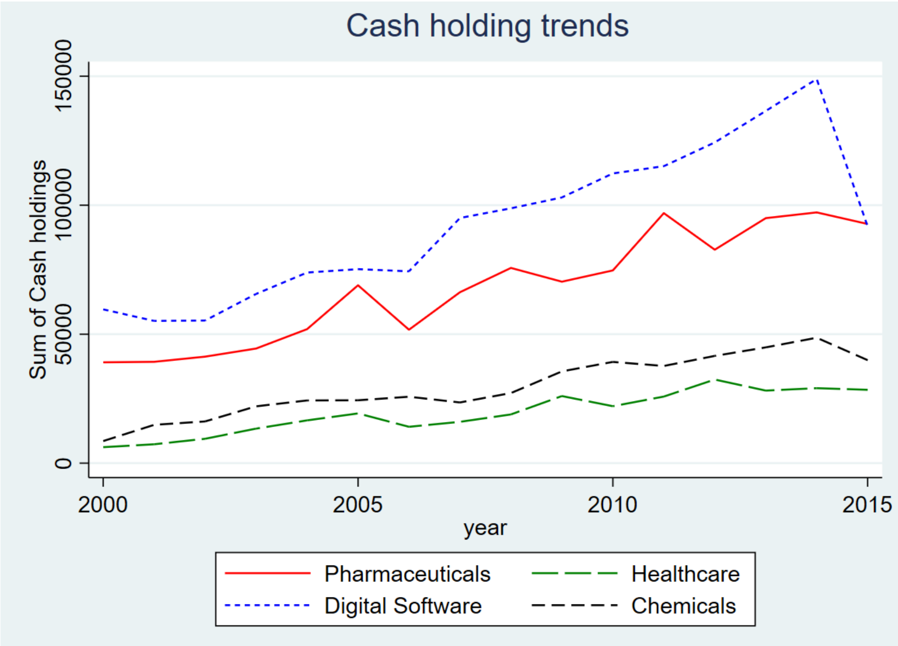
However, this action of precautionary saving would lead to the decrease in the level of overall investments, which contradicts the alternative hypothesis in #1(b) stating that cashflows keep a positive relationship with investments. Besides, in the last 20 years there has been a huge boost in the number of companies with main focus on R&D. As mentioned in both lecture and literature, this type of firms tend to own large amounts of intangible assets which are regarded as poor collaterals. The increase in difficulty of getting externally financed results in more cash saved in good state, which meanwhile cuts the cash for investments. And this is also backed by the regression outcomes, showing that the positive coefficient for cashflows/assets before 1990 also turns negative after 1990. Because there is an emerging trend of firms mainly with R&D spendings.

Hence, our financial constraint hypothesis could be adopted based on the time period examined. Specifically, cashflows positively predict the investment behaviour of a firm before 1990 while after 1990, the relation becomes negative.

Step #2. Presenting a Macroeconomic Analysis

Pharmaceuticals industry analysis

Overview of industries



Graph 1: Cash Holding Trends of 4 Industries

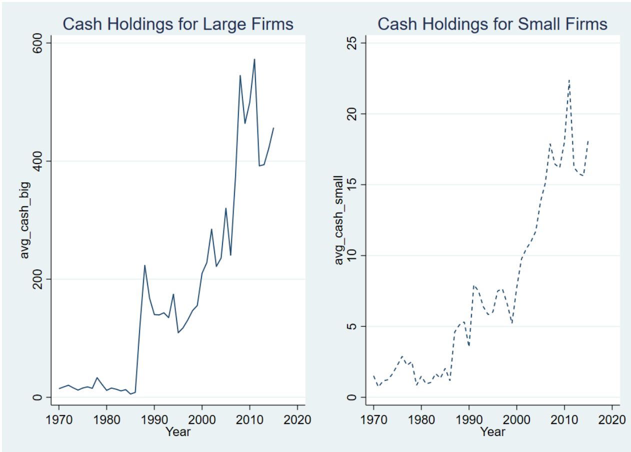
Cash reserves are variables related to a company's investment ratio. According to the Financial Constraint theory, higher cash reserves lead to higher investing. We choose the digital software, medical and chemical industries. The reason for this choice is that the three industries are closely related to the pharmaceutical industry. We will explain in detail the reasons for the connection.

First of all, the healthcare industry is an industry that can bring synergy to the pharmaceutical industry. The revival of the healthcare industry can make people more interested in health and naturally become more interested in healthy and effective drugs. Secondly, the chemical industry is also closely related to the pharmaceutical industry. The processes of pharmaceutical chemistry are closely related to the chemical industry. Finally, the digital software industry is also related to the pharmaceutical industry. The selection techniques of drugs to develop are also evolving after accurately identifying customers' needs through big data beyond simple previous market analysis. This means a greater amount of future demand, in other words, the growth of the digital software industry can have a great synergy effect on the growth of the pharmaceutical industry.

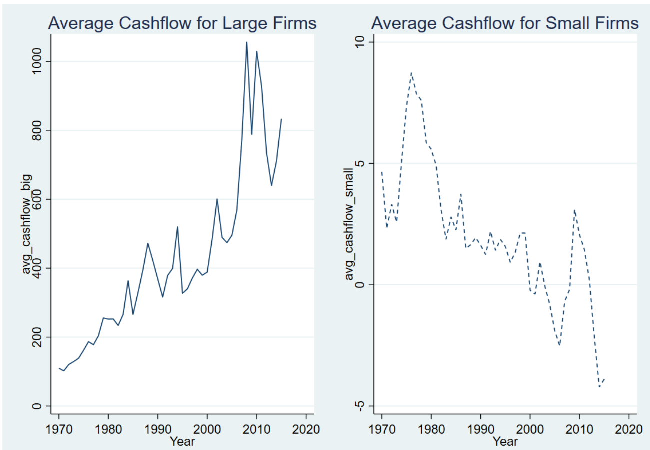
From the graph above, it can be seen that the trends of cash holdings in the healthcare industry, the chemical industry, and digital industries are on the rise. In other words, all three industries are more likely to invest and develop, which makes the pharmaceutical industry more attractive.

Information on annual cash holdings, debt usage, investment spending, and cash flows in the pharmaceutical industry

Large firms vs Small firms



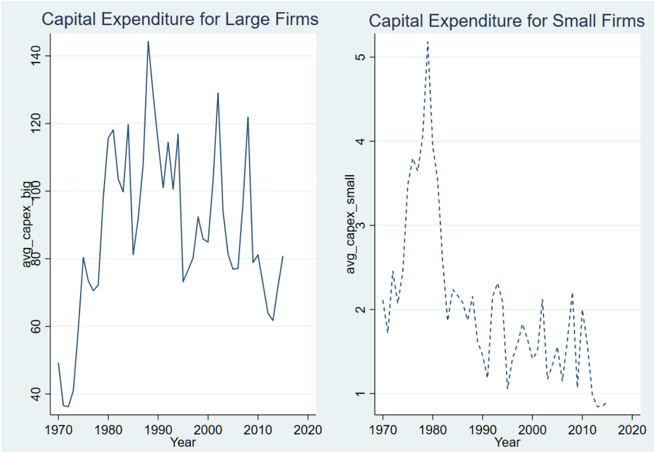
Graph 2: Cash Holding Trends of Large and Small firms



Graph 3: Cashflow Trends of Large and Small firms

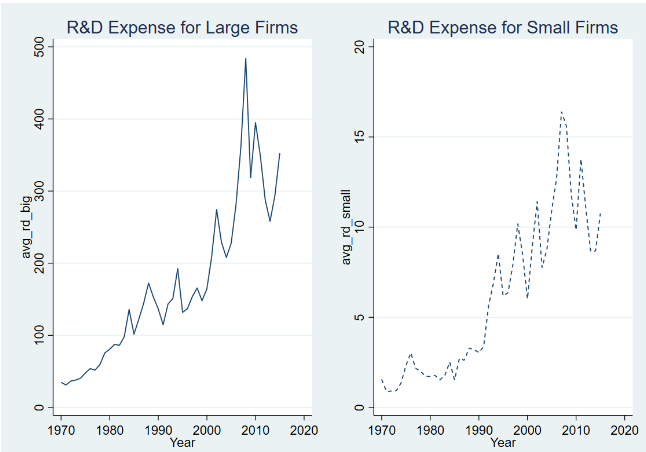
An upward trend in the cash holdings of firms can be noticed in both large and small firms. This uptrend appears to have begun in the 80s. What is interesting to note is that cashflows see an uptrend only for large firms. However, smaller firms see a negative trend in cashflows.

This shows two different reasons for holding cash. For small firms it appears that the nature of cash holdings is rather precautionary, trying to hold cash in case of negative cashflows. On the other hand, larger firms might be holding cash because of a lack of investment opportunities.



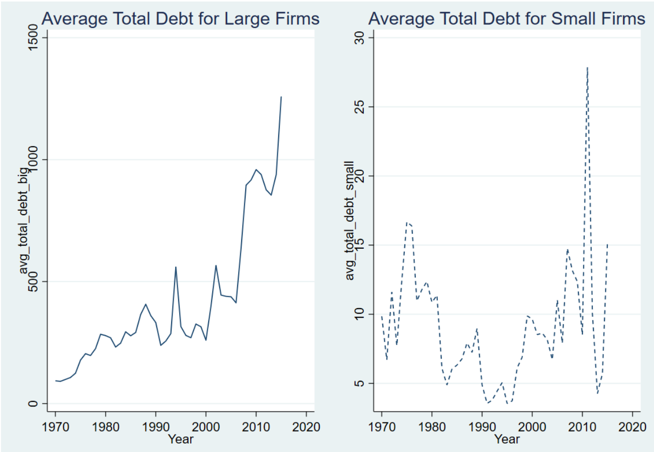
Graph 4: Capital Expenditures Trends of Large and Small firms

This is further proven by taking a look at average yearly capital expenditures. For large firms, average capital expenditures seem to have increased between the 70s and late 80s, then staying sideways from the 90s onwards, with some peaks. On the other hand, capital expenditures for small firms appear to have peaked in 1980, then fell and stayed below a level of $2M.



Graph 5: R&D Expense Trends of Large and Small firms

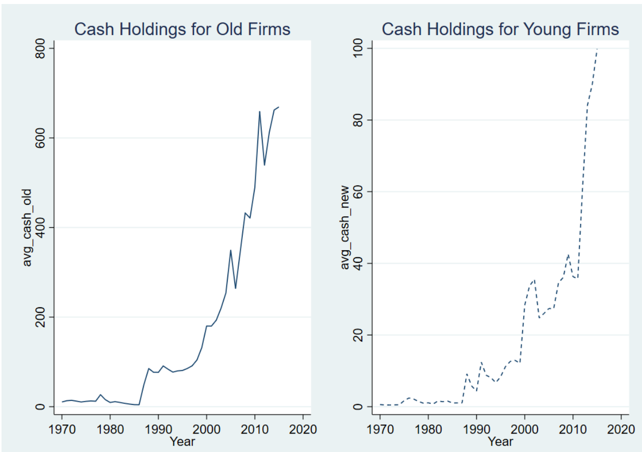
However, this might also be caused by the changing nature of firms. As years pass by, firms become much more reliant on research, non-tangibles, and other intellectual assets, rather than PP&E. Therefore, it is possible that smaller firms focus on R&D as a form of investment and due to their size they must manage their cash appropriately. This can be seen on the graph. Both small and large firms see an increase in R&D expenses, especially in the late 90s with the increase in the number of tech firms.



Graph 6: Average Total Debt Trends of Large and Small firms

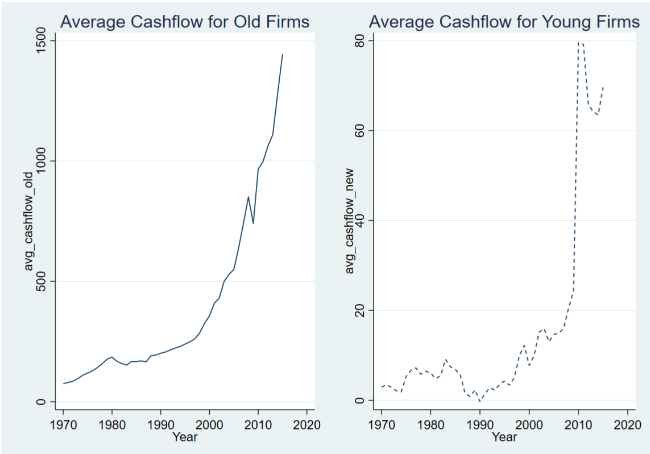
Another way to check the reason why firms hold cash is by checking where the firm get the cash from. Precautionary savings tend to come from retained earnings rather than debt, since firms save to deal with future expenses, rather than accumulating more expenses, such as debt expenses. In order to check for this, trends in total debt need to be evaluated. In the case of large firms it is clear that there is a strong increase in debt levels overtime. However, for small firms there is strong fluctuations, with debt levels rarely crossing $15M.

Old firms vs Young firms



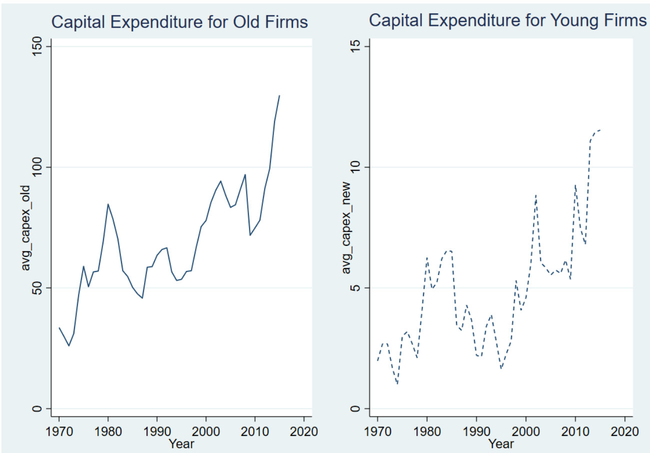
Graph 7: Average Cash Holding Trends of Old and Young firms

With the recent developments in the tech industry as well as the nature of firms, the differences between old and young firms might be of interest to investors. It appears that young firms follow the same cash holdings trends as older firms, with an uptrend starting in the 80s. The reasons for cash holdings increasing for both thus cannot be attributed to age necessarily.



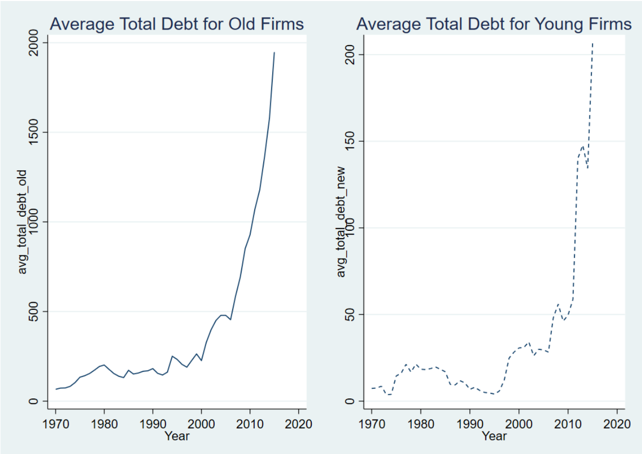
Graph 8: Average Cash Flows Trends of Old and Young firms

It appears that average cashflows follow an uptrend in both old and young firms. However, the development of the cashflows is different. While for old firms the growth pattern has been rather steady and taking off in the 90s, young firms appear to start their uptrend 1990 and growing steeply in the late 2000s. No precautionary motives can be concluded yet.



Graph 9: Average Capital Expenditure Trends of Old and Young firms

Looking at capital expenditures, old and young firms appear to follow the same trend again. There seems to be growth in both until mid-1980s, after which there is a fall. Starting in the 1990s there is growth continuing until 2020. This shows that precautionary earnings do not appear to be the reason for excess cash holdings. This is further proven with the trends in R&D expenses, since those have been growing exponentially since the 1990s.



Graph 10: Average Total Debt Trends of Old and Young firms

The usage of debt has changed drastically, increasing steeply for both old and young firms since the 2000s, which is further proof of firms not holding excess cash for precautionary reasons. This also shows that there is no significant difference in trends depending on firm age.

Short summary

In our conclusion, the data clearly indicate that only small pharmaceutical firms engage in precautionary saving. We analyze the pharmaceuticals industry with specific categories such as small, large, young, and mature firms in the sample period since 2000 and the whole sample period. Although we analyze the data in various and different situations, we found that similar results are observed over the various and different situations except cashflow capital expenditure and debt trends of large and small firms,. This difference shows that large firms tend to hold cash potentially due to a lack of investment opportunities. On the other hand, small firms showed a tendency to prepare upcoming threats and involvement in precautionary saving.

The line graphs are used to compare the cash holdings and investment. As a result, the amounts of cash holdings and investment of the pharmaceutical firms have increased with a similar slope in the same period. In other words, large pharmaceutical firms do not avoid investing cash holding into the investment instead of saving cash for precautionary reasons. Therefore, we conclude that large pharmaceutical firms do NOT holding cash mostly for precautionary reasons.

Appendix

	(1) SmallerFirm	(2) LargerFirm
w_tq_lag	0.0279*** (28.81)	0.0189*** (15.65)
w_cashflows_assets	0.0006 (0.08)	0.0455** (2.72)
_cons	0.0658*** (46.54)	0.0662*** (29.81)
N	47203	33381
R^2	0.1271	0.1040

t statistics in parentheses
** p<0.05, ** p<0.01, *** p<0.001*

Table A.1: Regression Output (Adding Firm-Size Dummy)

	(1) MoreFC	(2) LessFC
w_tq_lag	0.0245*** (24.92)	0.0027** (2.74)
w_cashflows_assets	-0.1356*** (-15.36)	0.5718*** (26.92)
_cons	0.0527*** (41.85)	0.0212*** (7.07)
N	39327	41257
R^2	0.2120	0.1755

t statistics in parentheses
** p<0.05, ** p<0.01, *** p<0.001*

Table A.2: Regression Output (Adding Financial Constraint Dummy)

Stata Code

```
bysort gvkey(capital_expenditures): drop if missing(capital_expenditures[_N])
bysort gvkey(short_term_debt): drop if missing(short_term_debt[_N])
bysort gvkey(long_term_debt): drop if missing(long_term_debt[_N])
bysort gvkey(market_capitalization): drop if missing(market_capitalization[_N])
bysort gvkey(cashflows): drop if missing(cashflows[_N])
gen investment = (capital_expenditures + r_and_d_investment)/book_assets //Y variable +r_and_d_investment
gen tq = (market_capitalization+short_term_debt+long_term_)/book_assets //Calculating Q, Tobin's Q =
(market value of firm)/replacement cost of capital
gen cashflows_assets = cashflows/book_assets //For determining financial constraint
sort gvkey year
//by gvkey: gen investment_lag = investment[_n-1]
by gvkey: gen tq_lag = tq[_n-1]
//by gvkey: gen cashflows_assets_lag = cashflows_assets[_n-1]
//I think only Tobin's Q should be lagged
//ssc install winsor
winsor investment, p(.01) gen(w_investment)
winsor tq_lag, p(.01) gen(w_tq)
winsor cashflows_assets, p(.01) gen(w_cashflows_assets)
//simultaneously test Q theory and financial constraint theory
reg w_investment w_tq w_cashflows_assets, cluster(gvkey)
est store Model1
//Control for Financial constraint
mean(w_cashflows_assets)
reg w_investment w_tq w_cashflows_assets if w_cashflows_assets < 0.0882609 , cluster(gvkey)
est store MoreFC
reg w_investment w_tq w_cashflows_assets if w_cashflows_assets >= 0.0882609 , cluster(gvkey)
est store LessFC
//fixed effect: size? age? and also year: the macro effect
xi: reg w_investment w_tq w_cashflows_assets i.year, cluster(gvkey)
xi: reg w_investment w_tq w_cashflows_assets i.firm_age, cluster(gvkey)
gen size = ln(market_capitalization+short_term_debt+long_term_)
reg w_investment w_tq w_cashflows_assets if size <= 4.981021, cluster(gvkey)
est store SmallerFirm
reg w_investment w_tq w_cashflows_assets if size > 4.981021, cluster(gvkey)
est store LargerFirm
//before 1990 and after 1990
reg w_investment w_tq w_cashflows_assets if year<1990, cluster(gvkey)
est store Model2
reg w_investment w_tq w_cashflows_assets if year>=1990, cluster(gvkey)
est store Model3
esttab Model1 Model2 Model3, b(%9.4f) scalars(r2) mtitles title("table1")
esttab SmallerFirm LargerFirm, b(%9.4f) scalars(r2) mtitles title("table2")
esttab MoreFC LessFC, b(%9.4f) scalars(r2) mtitles title("table3")
```

Q2-a

```
cls //this clears the screen
clear all //this clears the memory
// set project folder
cd "{path}"
use case1_dataset
//Describe the dataset
desc
// Show the summary of the dataset
sum
drop if year<2000 // Drop data before year 2000
// Q2 - a
// Generate variable that contains cash data categorised by industries
// Make a variable showing yearly sum values of cash "Pharmaceuticals"
egen sum_phr_cash_holding_yearly = sum(cash)      if industry == "Pharmaceuticals", by(year)
```

```
egen sum_health_cash_holding_yearly = sum(cash)      if industry == "Healthcare", by(year)
egen sum_Ch_cash_holding_yearly = sum(cash)      if industry == "Chemicals", by(year)
egen sum_d_soft_cash_holding_yearly = sum(cash)      if industry == "Digital Software", by(year)
// Make combined graphs
twoway line sum_phr_cash_holding_yearly sum_health_cash_holding_yearly sum_d_soft_cash_holding_yearly
sum_Ch_cash_holding_yearly    year , sort lpattern(solid longdash shortdash dash )    lw(tick middle middle
middle) lc(red green blue black)    legend(order( 1 "Pharmaceuticals" 2 "Healthcare"    3 "Digital Software" 4
"Chemicals")) title("Cash holding trends")    ytitle("Sum of Cash holdings") xtitle("year")
```

Q2-b

```
clear all
cls
use "C:\Users\user\Desktop\master\Semester 1\ACF\Assignments\case1_dataset.dta"
// br
// describe
//Of relevance cash, short_term_debt, long_term_debt, cashflows, cashflow_volatility, used_credit_line,
industry, total_liabilities, r_and_d_investment, PPandE, acquisitions, datadate, year, gvkey. Not dropping
anything but keeping in mind.
//Only Pharma relevant, so keep pharma only
keep if industry == "Pharmaceuticals"
tsset gvkey year
//Check if data skewed, found mode of year frequency using ssc hsmode option, so I capture all firms
// hist firm_age if year==2005, freq
// hist market_capitalization if year==2005, freq
// hist year, freq
//Use median to separate because of how skewed data is
//Separate by age using dummy variable old
egen median_age = median(firm_age) if year==2005
replace median_age = 14 if median_age==.
gen old = 1 if firm_age > median_age
replace old = 0 if old==.
tsset gvkey year
//generate total debt
gen total_debt = short_term_debt + long_term_debt

//creating mean values of different variables by age and year
sort old year
by old year: egen avg_cash = mean(cash)
by old year: egen avg_cashflow = mean(cashflows)
by old year: egen avg_rd = mean(r_and_d_investment)
by old year: egen avg_capex = mean(capital_expenditures)
by old year: egen avg_total_debt = mean(total_debt)
label var avg_cash "Average Cash Holdings"
label var avg_cashflow "Average Cashflow"
label var avg_rd "Average R&D Expense"
label var avg_capex "Average Capital Expenditure"
label var avg_total_debt "Average Total Debt"
label var year "Year"
//blank for new vars -> remember to put them in the next two loops if need be
// by old year: egen avg_x = mean(x)
// by old year: egen avg_x = mean(x)
// by old year: egen avg_x = mean(x)
//separating for graph
global list1 avg_cash avg_cashflow avg_capex avg_rd avg_total_debt
foreach var of global list1 {
    gen `var'_old = `var'*old
        replace `var'_old=. if `var'_old==0
        gen `var'_new = `var' if `var'_old==.
}
//graphs
```

```
// preserve
// foreach var of global list1 {
//         graph twoway line `var'_old `var'_new year, legend(label(1 "Old Firms") label(2 "Young Firms")) title(`: variable label `var'' by Firm Age) name(`var'_graph)
//             graph export `var'_old.png
//
// }
foreach var of global list1 {
            graph twoway line `var'_old year, lpattern(solid) lw(vtick) title(`: variable label `var'' for Old Firms ) name(`var'_graph_old)
            graph twoway line `var'_new year, lpattern(shortdash) lw(vtick) title(`: variable label `var'' for Young Firms ) name(`var'_graph_new)
            graph combine `var'_graph_old `var'_graph_new, name(`var'_graph)
            }
---------------------------------------------------------------------------------------------------------------
//same process with market cap
//easier than working around previous code
// clear all
// cls
// use "C:\Users\user\Desktop\master\Semester 1\ACF\Assignments\case1_dataset.dta"
// keep if industry == "Pharmaceuticals"
// tsset gvkey year
// egen median_size = median(market_capitalization) if year==2005
// replace median_size = 195.0373 if median_size==.
// gen big = 1 if market_capitalization > median_size
// replace big = 0 if big==.
//
// tsset gvkey year
// gen total_debt = short_term_debt + long_term_debt
//
//
// //creating mean values of different variables by age and year
// sort big year
//
// by big year: egen avg_cash = mean(cash)
// by big year: egen avg_cashflow = mean(cashflows)
// by big year: egen avg_rd = mean(r_and_d_investment)
// by big year: egen avg_capex = mean(capital_expenditures)
// by big year: egen avg_total_debt = mean(total_debt)
//
// label var avg_cash "Average Cash Holdings"
// label var avg_cashflow "Average Cashflow"
// label var avg_rd "Average R&D Expense"
// label var avg_capex "Average Capital Expenditure"
// label var avg_total_debt "Average Total Debt"
//
// label var year "Year"
// //blank for new vars -> remember to put them in the next two loops if need be
// // by big year: egen avg_x = mean(x)
// // by big year: egen avg_x = mean(x)
// // by big year: egen avg_x = mean(x)
//
// //separating for graph
// global list1 avg_cash avg_cashflow avg_capex avg_rd avg_total_debt
// foreach var of global list1 {
//         gen `var'_big = `var'*big
//             replace `var'_big=. if `var'_big==0
//             gen `var'_small = `var' if `var'_big==.
// }
//
```

```
// //graphs
// // preserve
// // foreach var of global list1 {
// //       graph twoway line `var'_big `var'_new year, legend(label(1 "Large Firms") label(2 "Small Firms"))
title(`: variable label `var'' by Firm Size) name(`var'_graph)
// //       graph export `var'_big.png
// //
// // }
// // lpattern(solid longdash shortdash dash )    lw(tick middle middle middle)
//
//
//
// foreach var of global list1 {
//        graph twoway line `var'_big year, lpattern(solid) lw(vtick) title(`: variable label `var'' for Large Firms )
name(`var'_graph_big)
//        graph twoway line `var'_small year, lpattern(shortdash) lw(vtick) title(`: variable label `var'' for Small
Firms ) name(`var'_graph_small)
//        graph combine `var'_graph_big `var'_graph_small, name(`var'_graph)
//        }
//
//
// // foreach var of global list1 {
// //       graph twoway line `var'_big year, lpattern(solid) lw(vtick) title(`: variable label `var'' for Large Firms )
name(`var'_graph_big)
// //       graph twoway line `var'_small year, lpattern(shortdash) lw(tick) title(`: variable label `var'' for Small
Firms ) name(`var'_graph_small)
// //       graph combine `var'_graph_big `var'_graph_small, name(`var'_graph)
// //       }
```

Reference:

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