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INVESTMENT AND GROWTH OPPORTUNITY BETWEEN CRISES AND POST-CRISES PERIODS UNDER FINANCING CONSTRAINT CRITERIA: EVIDENCES FROM BRAZILIAN PUBLICLY TRADED FIRMS

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Orientador: Prof. Dr. João Zani

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RESUMO

Esta pesquisa teve como objetivo investigar empiricamente se existem diferenças em investimentos, oportunidades de crescimento e geração de caixa entre crises e pós-crise períodos para empresas brasileiras, classificando empresas com os critérios de restrição financeira. Para alinhar com o objetivo, duas hipóteses são construídas. A primeira hipótese testa o objetivo já mencionado no primeiro parágrafo desta resumo, e a segunda hipótese investiga mais profundamente se existem diferenças de investimento para a sensibilidade do fluxo de caixa e a relação entre capital de giro e investimento entre crises e pós-crise para empresas brasileiras. Os resultados dos testes empíricos de duas hipóteses para empresas brasileiras não fornecem evidências definitivas de que existem diferenças das variáveis e das sensibilidades nesta hipóteses entre crises e pós-crise como argumentam outras teorias de finanças corporativas. Além disso, estas indiferenças são ainda maiores para empresas financeiramente restritas, ao contrário do sinal esperado destas hipóteses. Este resultado decorre do fato de que as empresas financeiramente restritas no Brasil têm uma profunda dificuldade financeira e dificilmente investem nos períodos de crise devido à escassez de crédito e este impacto continua em post-crise. As crises de crédito no mercado financeiro brasileiro reduzem ou quase eliminam o financiamento de investimentos. Em estudos futuros, é finalmente sugerido que os resultados desta pesquisa podem ser comparados com outros países emergentes.

PALAVARAS CHAVES: investimento, oportunidade de crescimento, sensibilidade ao fluxo de caixa, crise, pós-crise, restrição financeira

ABSTRACT

This thesis aims to investigate empirically whether there are differences in investments, growth opportunities and cash generation between crises and post-crisis periods for Brazilian firms, classified firms into the criteria of financial constraint. To align with the objective, two hypotheses are constructed. First hypothesis tests the objective in the first paragraph of this abstract, and second hypothesis investigate more deeply whether there are differences of investment to cash flow sensitivity and working capital relation to investment between crises and post-crises for Brazilian firms. The empirical test results of two hypotheses for Brazilian firms do not provide any definite evidences that there are differences of variables and sensitivities in hypotheses between crises and post-crises period as other corporate finance theories argue. Moreover, these indifferences are even greater for financially constrained firms in contrary to expecting sign of this thesis. These result arises from the fact that financially constrained firms in Brazil have a deep financial difficulty and hardly invest at the periods of crises due to credit shortages and this impact continues in post-crises. Brazilian credit crises in the financial market reduce or almost eliminate investment financing. In future studies, it is finally suggested that the results of this research can be compared with other emerging countries.

Keywords: investment, growth opportunity, cash flow sensitivity, crisis, post-crisis, financing constraint

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List of abbreviation

ADR	American Depository Receipts
BRICs	Brazil, Russia, India and China
BM&FBOVESPA (B3)	Bolsa de Valores de São Paulo, de Mercardorias e Futuros
EBITDA	Earnings before Interest, Taxes, Depreciation and Amortization
GMM	Generalized Method of Moments
OLS	Ordinary Least Squares
PPE	Plant, Property and Equipment
VIF	Variance Inflation Factors
2SLS	Two stage least squares

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1 Introduction

Investment-financing interaction (ALMEIDA and CAMPELLO, 2010) is to ensure funding for present and future investment in a world of financing frictions. MYERS (1984); MYERS and MAJLUF (1984) argue that *information asymmetry* (AKERLOF, 1970) between outside investors and insiders make firms to pass up positive NPV projects due to the increasing cost of firm's external funds. Consequently, firms prefer internal funds (MYERS, 1984).

Thereafter, FAZZARI, HUBBARD and PETERSEN (1988) introduced the studies on firm's *financial constraint* which may cause corporate underinvestment problem (KAPLAN and ZINGALES, 1997; CLEARY, 1999; ALMEIDA, CAMPELLO and WEISBACH, 2004; ACHARYA, ALMEIDA and CAMPELLO, 2007; DUCHIN, OZBAS and SENSOY, 2010; ALMEIDA and CAMPELLO, 2010; CAMPELLO, GRAHAM, HARVEY, 2010).

Thus, regarding the internal funds and investment, FAZZARI, HUBBARD and PETERSEN (1988; 2000) and KAPLAN and ZINGALES (1997; 2000) debated[1] whether investment-cash flow sensitivity is useful measure to classify firms into financially constrained or unconstrained. The firms' increased sensitivity to cash flow (FAZZARI, HUBBARD and PETERSEN, 1988; FAZZARI, HUBBARD and PETERSEN, 2000; KAPLAN and ZINGALES, 1997; KAPLAN and ZINGALES, 2000) is one of the main factors to explain the higher level of their cash holdings (BYOUN, 2011; DEANGELO and DEANGELO, 2007; DEANGELO, GONÇALVES AND STULZ (2016); DENIS and MCKEON, 2012; GAMBA and TRIANTIS; 2008; MACHICA and MURA, 2010) in the post-crisis period. They argue that financial crisis can make the management policies of firms very conservative even after the economy recovers from the crisis.

Throughout Asian financial crisis (1997) and Sub-prime Mortgage credit crisis (2008), the ability of a firm to respond effectively for unanticipated exogenous shocks to its cash flows or its investment opportunities which is called as financial flexibility (BANCEL and MITTO, 2004; BANCEL and MITTO, 2011; GRAHAM and HARVEY, 2001) have drawn the attention of firms' manager. Financial flexibility has already mentioned with various expressions in prior literature such as *untapped borrowing power* (MODIGLIANI and MILLER, "MM", 1963), *unused debt capacities*[2] (DEANGELO and DEANGELO; 2007; BANCEL and MITTO, 2011;

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1 See chapter 2.4.3.

2 High unused (spared) debt capacity (ALLEN, 2000; CLEARY 1999; MM, 1963; ROZEFF, 1982) is known as "untapped borrowing power". Most financial flexibility literature (BYOUN, 2011; DEANGELO and

GAMBA and TRIANTIS; 2008; MM 1963; MARCHICA and MURA, 2010), and *financial slack* (the level of cash and unused line of credit relative to investment) which was defined by KAPLAN and ZINGALES (1997).

Meanwhile, negative shocks to the supply of external finance in the presence of financing frictions (JAFFEE and RUSSELL, 1976; STIGLITZ and WEISS, 1981; HOLMSTROM and TIROLE, 1997) might hamper investment if firms lack sufficient financial slack (BANCEL and MITTO, 2004; BANCEL and MITTO, 2011; GRAHAM and HARVEY, 2001) to fund all profitable investment opportunities internally (DUCHIN, OZBAS and SENSOY, 2010).

SONG and LEE (2012) investigated the long-term effect of the Asian financial crisis on corporate cash holdings in eight East Asian countries. The median cash to assets ratio for the Asian firms almost had doubled from 6.7% in 1996 to 12.1% in 2006, and the sudden increase in cash holdings had been pervasive regardless of financial constraints. Their important finding is that the Asian firms build up cash holdings by decreasing investment activities such as capital expenditures and acquisitions after the crisis.

Crisis also amplify and propagate the effects of initial real or monetary shocks (BERNANKE, GERTLER and GILCHRIST, 1996) and this is why crisis period offers clear view to observe the behaviors of financing constrained firms. According to BERNANKE, GERTLER and GILCHRIST (1996), *"small shocks, large cycle"* puzzle to worsen in credit-market conditions (financial accelerator), recession period (crisis) exacerbates borrowers' agency or information costs and they could receive a relatively lower credits extended (the flight to quality). As a result, it reduces the borrower's spending (Investment and working capital) and production for bank dependent[3] firms (DUCHIN, OZBAS and SENSOY, 2010; SONG and LEE, 2012).

DEANGELO, 2007; DEANGELO, GONÇALVES AND STULZ, 2016; DENIS and MCKEON, 2012; GAMBA and TRIANTIS, 2008; MACHICA and MURA, 2010) confirm that firms seek financial flexibility through low leverage and high cash holdings.

[3] According to them, bank-dependent firms that face high agency costs of borrowing are likely to be largely reliant on intermediated (as opposed to open market) forms of credit. They define bank-dependent firm to be one that has no commercial paper outstanding and has at least 50% of its short-term liabilities in the form of bank loans (BERNANKE, GERTLER and GILCHRIST, 1996, p. 12-13).

DUCHIN, OZBAS and SENSOY (2010) studied the effect of the financial crisis that began in August 2007 on corporate investment and they corroborate that, due to a causal effect of a supply shock, the decline is the greatest for firms that have low cash reserves or high net short-term debt, financially constrained, or operate in industries dependent on external finance.

In Brazil, firms' lack of access to long-term loans market makes firm managers depend more on internal funds for investment (PROCIANOY, 1994; PROCIANOY and CASELANI, 1997). In addition, VANCIN (2018) corroborates that obligatory minimum dividends to be distributed to shareholder by the legislation[4] has a direct and indirect impact on the companies' investment. In addition, this effect is even greater and more relevant for financially constrained firms.

There are many determinants which cause underinvestment. Building up cash holdings by decreasing investment after Asian crisis (SONG and LEE, 2012), impact on investment of obligatory minimum dividends in Brazil (VANCIN, 2018), or competition between investment and working capital within the limited pool of finance (FAZZARI and PETERSEN, 1993) affects differently for financially constrained firms or unconstrained firms between crisis and post-crisis. Moreover, growth opportunity (BERK, GREEN and NAIK, 1996; LANG, OFEK and STULZ, 1996) and the investment to cash flow sensitivity (internal fund) cannot be expelled from the discussion of investment accelerator (GROSSMAN, 1972).

Therefore, for firm's manager, to know the differences of investment behavior and growth opportunity between crisis and post-crisis for Brazilian publicly firms by their financing constraint status could be researchable theme because the empirical results help them to plan their timing of capital funds injection for investment if there are significant differences of investment or growth opportunities between crisis and post-crisis.

1.1 Problem of the thesis

CAMPELLO, GRAHAM and HARVEY (2010) surveyed 1050 CFOs in U.S., Europe, and Asia to assess whether the firms were credit constrained during the global financial crisis in 2008. They find that the inability to borrow externally causes many firms to bypass attractive investment opportunities, 86% of constrained U.S. CFOs responded that their investment in

[4] Law 6,404 / 1976

attractive projects had been restricted due to the difficulty in raising external finance, while 44% of unconstrained firms had been restricted.

According to ARSLAN, FLORACKIS and OZKAN (2010), during Sub-prime mortgage credit crisis period from 2007 to 2009, firms that are financially flexible prior to this crisis (1) have a greater ability to take investment opportunities, (2) rely much less on the availability of internal funds to invest, and (3) perform better than less flexible firms during the crisis. Under such financing friction, firms' funding cost of external funds for investment would be high (ALMEIDA and CAMPELLO, 2010; ARSLAN, FLORACKIS AND OZKAN, 2010; FAZZARI, HUBBARD and PETERSEN, 1988; HUBBARD, 1998).

In spite of tax benefit of debt (MYERS, 1984), the large, liquid, profitable firms demonstrate particularly low leverage because planning for future expenditures lead to conservative debt usage (GRAHAM, 2000). Moreover, STREBULAEV (2007) argues that firms with low leverage react differently to external economic shocks from firms with high leverage, in the presence of frictions, firms adjust their capital structure infrequently, and as a consequence, the leverage of most firms is likely to differ from the "optimum" leverage at the time of readjustment.

However, to maintain high cash and low leverage for profitable firm may generate free cash flow (JENSEN, 1986) problem which manager have incentive to expropriate (LA PORTA et al., 2000), or, the risk aversion behavior of entrenched manager which reduces firm value. Whereas, financially constrained firm would reduce their investment due to information asymmetry (*flight to quality*) during crisis (BERNANKE, GERTLER and GILCHRIST, 1996).

According to FAZZARI, HUBBARD and PETERSEN (1988), the investment of firms that exhaust all their internal finance is more sensitive to fluctuations in cash flow than that of mature, high-dividend firms. According to them, if the cost disadvantage of external finance is significant, firms that retain and invest most of their income may have no low-cost source of investment finance, and their investment should be driven by fluctuations in cash flow. KAPLAN and ZINGALES (1997) also corroborate that firms that appear less financially constrained exhibit significantly greater sensitivities than firms that appear more financially constrained, however, they assert that higher sensitivities cannot be interpreted as an evidence that firms are more financially constrained.

Crisis can affect investments differently by firms' financing constraint, however, it is not known whether there are differences of investment behavior, growth opportunity and cash

generation between crises and post-crises for Brazilian firms. Not knowing these differences can cause underinvestment, or excessive free cash flow which can generate agency problem for the precautious managers of financially constrained firms and unconstrained firms in different ways in Brazil. Therefore, the present thesis aims to investigate empirically the following question: Are there differences of investments, growth opportunities and cash generations between crises and post-crises periods for Brazilian firms?

1.2 Objective of the thesis

This section presents general objective and specific objectives which are defined by this thesis.

1.2.1 General Objective

The objective of this thesis is to investigate empirically whether there are differences of investments, growth opportunities and cash generations between crises and post-crises periods for Brazilian firms.

1.2.2 Specific Objective

To achieve the objective of this research, the specific objectives are as follows;

- ✓ Investigate empirically whether there are differences of investment to cash flow sensitivity and working capital relation to investment between crises and post-crises for Brazilian firms.

1.3 Justification of the thesis

Investment under financing constraint (FAZZARI, HUBBARD and PETERSEN, 1988; KAPLAN and ZINGLES, 1997; CLEARY, 1999) had been popular literature in 1990s. However, the recurrences of crises made academic researchers (ARSLAN, FLORACKIS and OZKAN, 2006; ARSLAN, FLORACKIS and OZKAN, 2010; BANCEL and MITTO 2011; BYOUN, 2011; DEANGELO, GONÇALVES AND STULZ, 2016; GUNEY, OZKAN and OZKAN, 2007; MARCHICA and MURA, 2010) more focused on the financial flexibility.

Therefore, the addition of one of commonly utilized financial flexibility criteria such as cash holdings and leverage (ARSLAN, FLORACKIS and OZKAN, 2010; BYOUN, 2011; DEANGELO, GONÇALVES AND STULZ, 2016; GUNEY, OZKAN and OZKAN, 2007; MARCHICA and MURA, 2010; KAPLAN and ZINGALES, 1997) into the traditional financing constraints criteria of payout, firm size and firm age (ALMEIDA, CAMPELLO and WEISBACH, 2004; ACHARYA, ALMEIDA and CAMPELLO, 2007; DUCHIN, OZBAS and SENSOY, 2010; ALMEIDA and CAMPELLO, 2010; GILCHRIST and HIMMELBERG, 1995; PORTAL, ZANI and SILVA, 2012; PORTAL, ZANI and SILVA, 2013; ZANI, 2005) can be the opportunity of this research whether the added criteria bring out similar results with other traditional criteria which indicate firm's financing constraint status in empirical tests.

The insertion of the variable of change of working capital (ΔWC) by FAZZARI and PETERSEN (1993) into the reduced-form investment equation of FAZZARI, HUBBARD and PETERSEN (1988)[5] (GERTLER and HUBBARD, 1988; KAPLAN and ZINGALES, 1997; CLEARY, 1999; ALMEIDA and CAMPELLO, 2007) is essential to verify the relationship with investment. FAZZARI and PETERSEN (1993) find that WC and investment has negative relationship with fixed investment if both compete in a limited pool of finance. This thesis sheds a light on the possibility that, during crisis, "limited pool of finance" is more severe to the firms with financing constraint because "flight to quality" (BERNANKE, GERTLER and GILCHRIST, 1996) may lead Brazilian financial institutes to operate only with financially unconstrained firms. Consequently, financially constrained firms should choose investment to *grow* (BODIE, KANE and MARCUS, 2014) or working capital to *survive* (PADACHI, 2006) when their "limited pool of finance" (financial source) is severe with the information asymmetry. This is why the second hypothesis of this study tests not only for the investment to cash flow sensitivity but also for the relationship between change of working capital and investment.

The introduction of instrumental variables, due to the endogeneity, are necessary for the comparison of investment to cash flow sensitivity and working capital relations to investment between crisis and post-crisis by firm's financing constraint status. This study added two-year lags of cash flow as the instrumental variables with two stage least squares estimators.

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[5] Thereafter, it is mentioned as "FAZZARI, HUBBARD and PETERSEN (1988)'s reduced-form investment equation" in this thesis.

It is not only to solve the endogeneity problem of the estimations[6], but also, it is reasonable to relate the lagged internally accumulated profits (retained earnings) of firms to the investment because firm cannot invest only with the current years' profit under the assumptions that firm prefers internal funds for investment (MYERS, 1984). Crises have been repeated in Brazil, however it is still not known that investments, growth opportunities and cash flows between crises and post-crises periods reacts differently according to the firms' financing constraint status. As previously stated, obligatory minimum payouts and firm's lack of access to long-term loans in Brazil make firm managers depend more on internal funds for investment (PROCIANOY, 1994; PROCIANOY and CASELANI, 1997; VANCIN, 2018). Hence, investment to cash flow and working capital competition with investment during crisis for financially constrained firms are expected to be more sensitive and negatively related than those of post-crisis.

The other differentiation of this study from the previous literature is the binary classification of the periods of *crisis* and *post-crisis* with multiple years, which DUCHIN, OZBAS and SENSOY (2010) argue that this type of approach has the additional advantage of averaging out any seasonal patterns in the data. Also, it is important for firm managers to know whether there are differences of investment and growth opportunities between crises and post-crises, if the differences are proved to be significant between two periods, managers can maintain or delay their investment based on their firms' financing constraint status and which period they are in.

This thesis justifies that Brazilian financial characteristics of short term financing and lack of access to external funds for investment of Brazilian firms may lead to different results from the studies in developed or emerging countries.

1.4 Organization of the thesis

The first chapter presents research theme, problem of the research, the objective and justification of the research. Second chapter presents theories to build the hypotheses to be tested. Third chapter presents testable hypothesis, method and econometric procedure. Fourth

[6] See chapter 4.2.2.3.

chapter analyzes empirical test results. Fifth chapter ends up with final considerations of this research.

2 Theoretical reference

This chapter provides theoretical bases to carry out the research. Starting from irrelevance of capital structure argued by MODIGLIANI and MILLER (1958), information asymmetry, agency cost on investment, financing constraint and financial flexibility on investment, investment under crisis and economic crises in Brazil are reviewed in order. With these theoretical understandings, the hypotheses for this thesis are to be constructed in the chapter 3.

2.1 Irrelevance of capital structure by MODIGLIANI and MILLER (1958)

For the capital cost to finance corporate investment, MODIGLIANI and MILLER (1958) started their article with a question "what is the cost of capital to firms which are used to acquire asset whose yields are uncertain?" They argue that this question vexed the contemporary economists such as corporate finance specialists who concerns with the techniques of financing firms to ensure their survival and growth.

COPELAND and WESTON (1992, p. 330-331) summarized MODIGLIANI and MILLER (1958)'s perfect capital market assumptions in the propositions of frictionless market hypothesis as below.

> • Markets are frictionless; i.e., there are no transactions costs or taxes, all assets are perfectly divisible and marketable, and there are no constraining regulations.
> • There is perfect competition in product and securities markets. In product markets, this means that all producers supply goods and services at minimum average cost, and in securities markets it means that all participants are price takers.
> • Markets are informationally efficient; i.e., information is costless, and it is received simultaneously by all individuals.
> • All individuals are rational expected utility maximizers.

MODIGLIANI and MILLER (1958) argue that the earlier theorists have concluded that the cost of capital to the owners of a firm is the rate of interest on bonds. In addition, it has

derived the familiar proposition that the firm, acting *rationally*, will tend to push investment to the point where the marginal yield on physical assets is equal to the market rate of interest. However, due to the existence of uncertainty, with the notion of a "risk discount" to be subtracted from the expected yield (or a "risk premium" to be added to the market rate of interest), investment decisions are then supposed to be based on a comparison of this "risk adjusted" or "certainty equivalent" yield with the market rate of interest. Their prepositions are as below.

MODIGLIANI and MILLER Propositions

Firms have different proportions of debt in their capital structure, shares of different firms, even in the same class, can give rise to different probability distributions of returns. MM argue that the shares will be subject to different degrees of financial risk or leverage and hence they will no longer be perfect substitutes for one another.

The expected return on the assets owned by the company *j* (its expected profit before deduction of interest (X) divided by appropriate capitalization rate (ρ)) is equal to sum of the market value of the debts of the company (D_j) and the market value of its common shares (S_j).

Proposition I

MODIGLIANI and MILLER (1958)'s *proposition I* is that *the market value of any firm is independent of its capital structure and is given by capitalizing its expected return at the rate ρ_k appropriate to its class.*

$$V_j \equiv S_j + D_j = X_j / \rho_k; \text{ for any firm } j \text{ in class } k \quad (1)$$

This proposition can be restated in an equivalent way in terms of the firm's "average cost of capital," X_j/V_j, which is the ratio of its expected return to the market value of all its securities. The equation (1) then can be re-written as below,

$$X_j / (S_j + D_j) \equiv X_j/V_j = \rho_k, \text{ for any firm j, in class } k, \quad (2)$$

That is, *the average cost of capital to any firm is completely independent of its capital structure and is equal to the capitalization rate of a pure equity stream of its class.*

Proposition II

MODIGLIANI and MILLER (1958) derive the following proposition concerning the rate of return on common stock in companies whose capital structure includes some debt: the

expected rate of return or yield, *i,* rate of interest, *r*, on the stock of any company *j* belonging to the *k*th class is a linear function of leverage as follows:

$$i_j \equiv \rho_k + (\rho_k - r)\, D_j / S_j \qquad (3)$$

MODIGLIANI and MILLER (1958) document that *"The expected yield of a share of stock is equal to the appropriate capitalization rate ρ_k for a pure equity stream in the class, plus a premium related to financial risk equal to the debt-to-equity ratio times the spread between ρ_k and r.* Or equivalently, the market price of any share of stock is given by capitalizing its expected return at the continuously variable rate i_j in the equation (3)."

Proposition III

MODIGLIANI and MILLER (1958)'s proposition III propose simple rule which is for optimal investment policy.

> If a firm in class *k* is acting in the best interest of the stockholders at the time of the decision, it will exploit an investment opportunity if and only if the rate of return on the investment, say ρ^*, is as large as or larger than ρ_k. That is, the cut-off point for investment in the firm will in all cases be ρ_k and will be completely unaffected by the type of security used to finance the investment.

The implication of above quotation is, regardless of the financing used, that the marginal cost of capital to a firm is equal to the average cost of capital, which is equal to the capitalization rate for an unlevered stream in the class to which the firm belongs.

FRANK and GOYAL (2007) criticize MODIGLIANI and MILLER (1958) theorem with the fact that debt and firm value both are plausibly endogenous and driven by other factors such as profits, collateral, and growth opportunities. While MODIGLIANI and MILLER (1958) theorem has been criticized not to provide a realistic explanation how firms finance their operations, MODIGLIANI and MILLER (1963) communicated to correct an error in their previous *proposition I* of MODIGLIANI and MILLER (1958), which restates *"The market values of firms in each class must be proportional in equilibrium to their expected returns net of taxes."*, supposing one firm may have an *expected* return after tax *twice* that of another firm in the same risk-equivalent class, actual return after taxes will not *double* if the two firms have different degrees of leverage.

Since the publication of the article in 1963, Modigliani and Miller have demonstrated the different opinions between them about the position on relevance or irrelevance on capital structure. MILLER (1977) asserted that the traditional approach ignores the compensating

clientele effect of personal taxes, therefore he insisted the indifference (irrelevance) position of value of firm which is independent of its capital structure despite the deductibility of interest payments in computing corporate income taxes.

MODIGLIANI and MILLER (1963) argue that investment planning must be financed by the mixture of debt and equity capital in the long-run, in addition, they emphasized the concept of *long-run target* debt ratio which its actual debt ratio will fluctuate as it "alternatively" floats debt issue and substitute it with internal or external debt equity (p. 441).

Even the perfect capital market assumption of MODIGLIANI and MILLER (1958) has been criticized due to the lack of reflection of the tax effect and firm's financing strategy (MODIGLIANI and MILLER, 1963), however, the initiation of questioning for cost of capital to acquire asset under the uncertainty opened the theoretical base for the subsequent corporate finance theorists which introduced trade-off of tax benefit and financial distress (MYERS, 1984), information asymmetry and agency cost which are also relevant to capital structure formulation.

2.2 Information asymmetry; Pecking Order Hypothesis and Trade-off theory

This chapter presents a theoretical bases to understand the mechanism of capital structure formulation; adverse selection rendered by bounded rationality, opportunism and moral hazard under information asymmetry when firm finances corporate investment with inefficiencies.

2.2.1 Information asymmetry and inefficiency: adverse selection, bounded rationality, opportunism and moral hazard

AKERLOF (1970)'s supposition is that there are good cars or bad cars in new or used car market, bad cars are called as *lemons* in America. Because sellers are presumed to have more knowledge about the quality of a car than buyers, and buyers have concern they might choose *lemon*, in the end, this information asymmetry between sellers and buyers finally results that car sellers cannot even sell good car in a reasonable price due to buyer's doubt (adverse selection).

Between outsiders and insiders of a firm, "Information asymmetry" hampers the cost wedge between internal funds and external funds. Simon (1955) established a series of questions about this rational behaviour, proposing a concept of bounded rationality which

considers the cognitive limitations of the agent responsible for the decision. Considering that information cannot be perfectly analyzed, managers seek satisfaction through their specific limitation of optimal choice and, consequently, they should make decisions within the bounded rationality.

According to WILLIAMSON (1985), bounded rationality is cognitive assumption on which semi-strong form of rationality in which economic actors are assumed to be "intendedly rational, but only limitedly so". He argues that opportunism represents self-interest seeking with guile such as lying, stealing, and cheating. Opportunism is responsible for real or contrived conditions of information asymmetry, which complicates the problems of organization. Information problems in debt markets will be less severe than those in external equity markets, but the marginal cost of debt will increase with leverage level (FAZZARI, HUBBARD and PETERSEN, 1988).

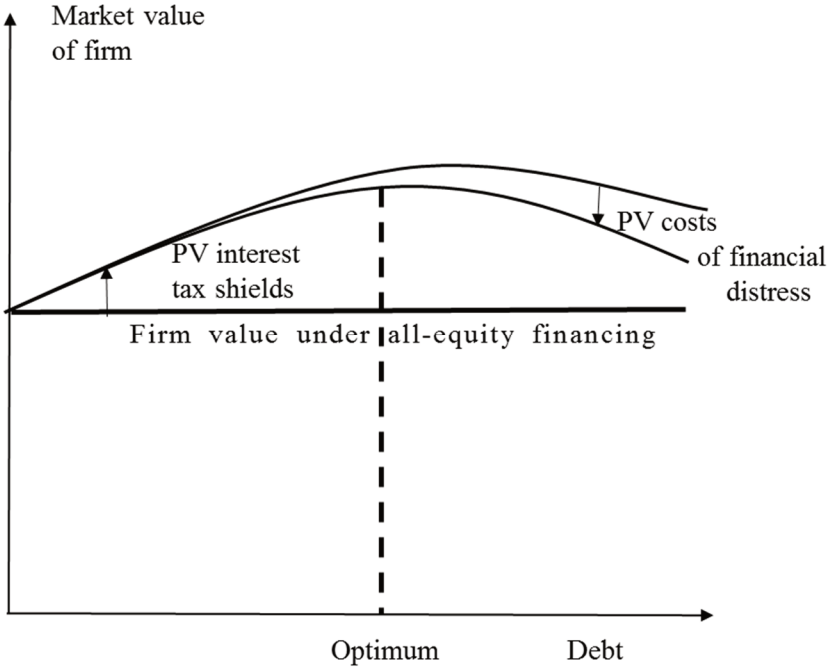
The information asymmetry on firm's financing policy is not negligible, therefore, in spite of comparable high cost of external funds (FAZZARI, HUBBARD and PETERSEN, 1988; HUBBARD, 1998), firms may reserve their own untapped borrowing power (MM, 1963) to cope with unexpected adverse economic shocks such as crisis. Information asymmetry causes lenders to ration credit in debt market (STIGLITZ and WEISS, 1981) when firms combine it with lack of collateral (JENSEN, 1986; CARPENTER and PETERSEN, 2002; ZANI, 2005), or, if they are small high-tech firms (HIMMELBERG and PETERSEN, 1994), or, if they are financially constrained firm (ALMEIDA and CAMPELLO, 2003; CLEARY, 1999; CAMPELLO, GRAHAM, HARVEY, 2010; FAZZARI, HUBBARD and PETERSEN, 1988; KAPLAN and ZINGALES, 1997; ZANI, 2005). Firms have poor access to debt may have more incentive to prefer internal funds (CARPENTER and PETERSEN, 2002; MYERS, 1984; MYERS and MAJLUF, 1984; SHYAM-SUNDER and MYERS, 1999) and this hypothesis is called as "(financing) pecking order".

2.2.2 Trade-off theory and Pecking order theory

According to MYERS (1984), a firm's optimal debt ratio is determined by a trade-off of the costs and benefits of borrowing, holding the firm's assets and investment plans constant. The firm is portrayed as balancing the value of interest tax shields against various costs of financial distress.

As illustrated in figure 1, a firm is supposed to substitute debt for equity, or equity for debt, until the value of the firm is maximized (up to optimum level of debt in horizontal axis). However, trade-off theory was questioned because it cannot account for the correlation between high profitability and low debt ratios[7].

Figure 1 Static trade off theory of optimal capital structure assumes that firms balance the marginal present values of interest tax shields against the costs of financial distress



Source: MYERS (1984); SHYAM-SUNDER and MYERS (1999)

MYERS (1984) contrasts two ways of thinking about previous capital structure theories in target debt ratio aspect. One is static tradeoff framework in which the firm is viewed as setting a target debt-to-value ratio and gradually moving towards it. The other is an old-fashioned[8] *pecking order* framework in which the firm shifts from internal to external financing.

[7] Due to the existence of adjustment costs (STREBULAEV, 2007) and lag to adjust for optimum capital structure promptly, firms cannot immediately offset the random events that bump them away from the optimum.

[8] MYERS (1984) contends in his article, old-fashioned (pure) pecking order framework (p. 576) already exists but he has not seen the term "pecking order" used before his article. (p. 581, foot note 8). The argument raised by MYERS (1984, p. 576) is that an old-fashioned pecking order framework raised by DONALDSON (1961). DONALDSON argues that reducing customary cash dividend payment was unthinkable to most managements except as a defensive measure in a period of extreme financial distress (p. 70).

In the pure (old) pecking order theory, the firm has no well-defined target debt-to-value ratio.

In contrast to the static tradeoff theory, MYERS (1984) defines financing pecking order as below:

> 1. Firms prefer[9] internal finance.
> 2. They adapt their target dividend payout ratios to their investment opportunities, although dividends are sticky and target payout ratios are only gradually adjusted to shifts in the extent of valuable investment opportunities.
> 3. Sticky dividend policies, plus unpredictable fluctuations in profitability and investment opportunities, mean that internally-generated cash flow may be more or less than investment outlays. If it is less, the firm first draws down its cash balance or marketable securities portfolio.
> 4. If external finance is required, firms issue the safest security first. That is, they start with debt, then possibly hybrid securities such as convertible bonds, then perhaps equity as a last resort. In this story, *there is no well-defined target debt-equity mix*, because there are two kinds of equity, internal and external, one at the top of the pecking order and one at the bottom. Each firm's observed debt ratio reflects its cumulative requirements for external finance.

Most of Brazilian capital structure studies (DE MEDEIROS AND DAHER, 2004; CORREA et al., 2007) tested the pecking order hypothesis in Brazil and they confirmed the existence of pecking order in Brazil, in addition, the results of past Brazilian empirical studies (BASTOS, NAKAMURA and BASSO, 2009; DE MEDEIROS and DAHER, 2008; NAKAMURA et al., 2007) also confirmed the negative relationship between the generation of internal funds and the demand for external funds (PORTAL, ZANI and SILVA (2012).

2.3 Agency costs which affect capital structure and corporate investment

Agency theory (JENSEN and MECKLING, 1976) opened the approach on how capital structure[10] is affected by managerial behavior such as conflict of interest, opportunism and risk aversion. JENSEN and MECKLING (1976) investigated the nature of the agency costs generated by the existence of debt and outside equity, and separation of ownership and control.

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[9] FRANK and GOYAL (2007)'s interpretation of the verb "prefer" is important for this thesis, according to them, it implies that "managers are reluctant, but, they should accept or use it as an alternative option".

[10] JENSEN and MECKLING (1976, p. 1) did not want to use the term 'capital structure' because that term usually denotes the relative quantities of bonds, equity, warrants, trade credit, etc., which represent the liabilities of a firm. Their theory implies that there is another important dimension to this problem—namely the relative amount of ownership claims held by insiders (management) and outsiders (investors with no direct role in the management of the firm).

They argue that optimal capital structure is able to be obtained by minimizing agency costs (FÁMA and GRAVA, 2000) which are caused by the conflicts of interests between shareholders, or between shareholders and managers, or between shareholders and creditors (LA PORTA, LOPEZ-DE-SILANES, SHLEIFER and VISHNY, 2000; YOUNG et al., 2008).

JENSEN and MECKLING (1976) conceptualized the agency costs which are incurred by the separation of ownership and control. They cited Adam Smith (1776)'s argument in the preface.

> The directors of such [joint-stock] companies, however, being the managers rather of other people's money than of their own, it cannot well be expected, that they should watch over it with the same anxious vigilance with which the partners in a private copartnery frequently watch over their own. Like the stewards of a rich man, they are apt to consider attention to small matters as not for their master's honor, and very easily give themselves a dispensation from having it.

According to JENSEN and MECKLING (1976), managers will act in their own economic self-interest which can be redirected by share ownership, compensation schemes. HARRIS and RAVIV (1991); LA PORTA, LOPEZ-DE-SILANES, SHLEIFER and VISHNY (2000) argue that managers can invest less effort in managing firm resources and may be able to transfer firm resources to their own personal benefit.

In relation to capital structure, JENSEN and MECKLING (1976) point out the risk aversion of entrenched managers (BERGER, OFEK and YERMACK, 1997; GRAHAM, 2000) who are appointed by controlling shareholders or a family member, which case is common in emerging countries (YOUNG et al., 2008). They may use less (conservative) debt due to the risk aversion which results in reduction of firm value (ANG, COLE and LIN, 2000; JENSEN and MECKLING, 1976; JENSEN, 1986; ROZEFF, 1982, STULZ, 1990).

To reduce the possibility of wasting or expropriating financial resources by managers, JENSEN (1986) suggests that firm should disgorge free cash to shareholders. Large cash holdings incur higher cost of inefficient uses when the firm does not have enough investment opportunities (JENSEN, 1986; LA PORTA, LOPEZ-DE-SILANES, SHLEIFER and VISHNY, 2000).

MYERS (1977) notes an agency cost of debt. He observes that when firms are likely to go bankrupt in the near future, shareholders may have no incentive to contribute with new capital to invest in value-increasing projects because shareholders should bear the entire cost

of the investment. But the returns from the investment may be captured mainly by the debt-holders with lower risk than shareholders. Thus, larger debt levels induce to the rejection of more value-increasing projects.

2.4 Corporate investment under financing constraint or financial flexibility

This chapter presents a financing constraint and financial flexibility literature review in relation to corporate investment.

2.4.1 Financing constraint and corporate investment by FAZZARI, HUBBARD and PETERSEN (1988)

FAZZARI, HUBBARD and PETERSEN (1988) investigated the relationship between financing constraints and investment-cash flow sensitivity. They conducted the analysis for manufacturing firms from 1970 to 1984[11] to test the hypothesis that the hedging role of cash is more critical in states of the world characterized by high asymmetric information and excessive costs of external finance. Under the equal access to capital markets, firms' responses to changes in the cost of capital or tax-based investment incentives differ only because of differences in investment demand.

According to FAZZARI, HUBBARD and PETERSEN (1988), the investment of firms that exhaust all their internal finance is more sensitive to fluctuations in cash flow than that of mature, high-dividend firms. Financial effects on investment are greatest at times when capital market information problems are likely to be most severe for high-retention firms. They note that, if internal and external finance are nearly perfect substitutes, however, then retention practices should reveal little about investment by the firm. Firms would simply use external finance to smooth investment when internal finance fluctuates.

FAZZARI, HUBBARD and PETERSEN (1988) document that, if the cost of capital differs by source of funds, the availability of finance will likely have an effect on the investment practices of some firms. In their financing hierarchy models which depicts the cost difference

[11] They use a large panel of Value Line data. Their classification scheme is to divide firms into three groups. Class 1 firms have a ratio of dividends to income less than 0.1 for at least 10 years. Class 2 firms have a dividend-income ratio less than 0.2, but more than 0.1, for at least 10 years. Class 3 includes all other firms (FAZZARI, HUBBARD and PETERSEN (1988, p. 158).

between source of funds and investment financing, the availability of internal funds allows firms to undertake desirable investment projects (MYERS, 1984) without resorting to high-cost external finance.

FAZZARI, HUBBARD and PETERSEN (1988, p. 164) describes the general form of the reduced-form investment equations that they examine is,

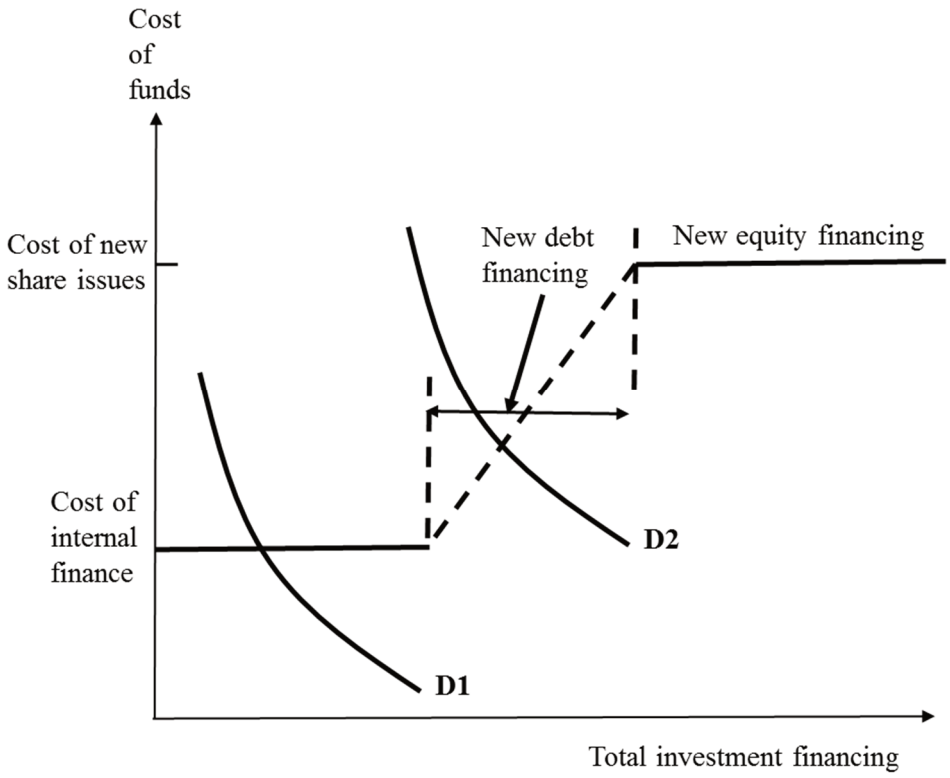
$$(I/K)_{it} = f\,(X/K)_{it} + g\,(CF/K)_{it} + u_{it} \qquad (4)$$

Where $\mathbf{I}_{it}$ represents investment in plant, property and equipment (PPE) for firm *i* during period *t*; **X** represents a vector of variables, possibly including lagged value, that have been emphasized as determinants of investment from a variety of theoretical perspectives; and *u* is an error term. The function *g* depends on the firm's internal cash flow (CF); it represents the potential sensitivity of investment to fluctuations in available internal finance after investment opportunities are controlled for through the variables in **X**. All variables are divided by the beginning-of-period capital stock *K*.

Regardless of the true economic process at the foundation of investment demand, the supply of low-cost finance, and therefore the level of internal cash flow, enters the reduced form investment equation of firms for which internal and external finance are not perfect substitutes. According to FAZZARI, HUBBARD and PETERSEN (1988), for the appropriate specification of the model's demand side, the most common approach is: 1) models based on q that emphasize market valuations of the firm's assets as the determinant of investment; 2) sales accelerator models in which fluctuations in sales or output motivate changes in capital spending; 3) neoclassical models that combine measures of output and the cost of capital to explain investment demand. They argue that most extensive tests of alternative specifications and estimation techniques are presented for the *q* model.

If the cost of capital differs by source of funds, the availability of finance will likely have an effect on the investment practices of some firms. In financing hierarchy models in figure 2, the availability of internal funds allows firms to undertake desirable investment projects without resorting to high-cost external finance. In addition, to the extent that a firm seeks debt finance at the margin, greater internal cash flow enhances its balance sheet and net worth positions, lowering the cost of new debt.

Figure 2 Investment and Financing decision



Source: FAZZARI, HUBBARD and PETERSEN (1988)

If the asymmetric information problem is important empirically, observed *q* values should be high relative to historical values before new share issues for limited-information firms. Internal finance constrains spending for firms that do not pay dividends and face an investment demand schedule like D2 in figure 2. When *Q* is sufficiently high, new shares are issued, and movements in Q lead to movements in investment. Otherwise, investment will be driven by changes in internal finance. More generally, the slope of the debt supply schedule will determine the extent to which firms can offset reductions in internal finance with greater leverage. Therefore, the larger the lemons premium, Ω, the greater the chances that a firm will have an investment demand curve like D2, where investment opportunities, as measured by a project's marginal Q, can vary, while investment responses are affected by the availability of internal finance.

Finally, their empirical results on firm investment suggest that models should address links between net worth and credit allocation and the possibility of precautionary retentions by many firms.

2.4.2 Capital market imperfection and investment by HUBBARD (1998)

A decade after FAZZARI, HUBBARD and PETERSEN (1988)'s publication of the article, HUBBARD (1998) commented a number of researchers have extended conventional models of fixed investment to incorporate a role of "financing constraint" in determining investment. According to the author, many models of asymmetric information and incentive problems in the capital markets have implied that information costs and the internal resources of a firm influence the shadow cost of external funds for fixed investment, holding constant underlying investment opportunities. The principal findings of the studies are that investment is significantly correlated with proxies for changes in net worth or internal fund and it is likely to face information related capital-market imperfection.

HUBBARD (1998) argues that financing constraints are motivated by the link between collaterizable net worth and the cost of debt (p. 198); (1) Uncollateralized external financing is more costly than internal financing; and (2) holding constant investment opportunities, a reduction in net worth reduces investment for firms facing information costs.

According to HUBBARD (1998), there are two main concerns and interests in links between "internal funds" and investment decisions, one "macro" and one "micro". The "macro" concern is that cyclical movements in investment appear too large to be explained by market indicators of expected future profitability or the user cost of capital. He agreed with BERNANKE, GERTLER and GILCHRIST (1996)'s "accelerator" model which refers to the magnification of initial shocks by financial market imperfections explains well regarding investment behavior[12] (GORDON, 1959). For "micro" concern relates to consequences of informational imperfections in credit markets. The problems of asymmetric information between borrowers and lenders lead to a gap between the cost of external financing and internal financing. The costly external financing stands in contrast to the more complete-markets approach underlying conventional models of investment emphasizing expected future profitability and the user cost of capital as the key determinants of investment.

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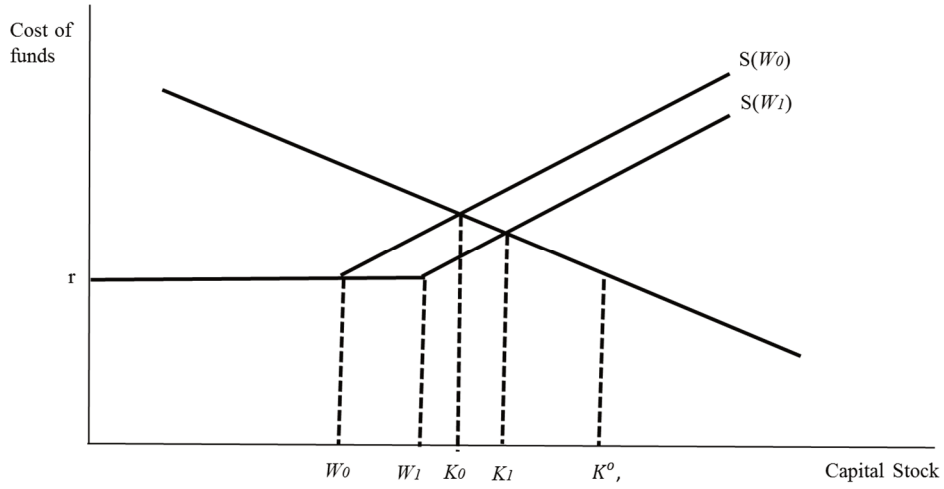
[12] In GORDON (1959)'s relations study among three variables (dividend, earnings, and stock price), the variation in price (P*) among common stocks is of considerable interest for the discovery of profitable investment opportunities, for the guidance of corporate financial policy, and for the understanding of the psychology of investment behavior. ($P^* = a_o + a_1 D + a_2 Y$, where P = the year-end price, D = the year's dividend, and Y = the year's income)

Figure 3 Informational imperfections and underinvestment



Source: HUBBARD (1998)

Figure 3 describes the links among net worth, the cost of external financing, and investment. The best desired capital stock is K^o, given information cost, the net worth W_0, the equilibrium capital stock is K_0. Holding information costs constant, when new worth increases from W_0 to W_1, the supply-of-funds curve shifts from S(W_0,) to S(W_1). The demand curve remains at D, holding investment opportunities constant. The increase in net worth, holding constant both information cost and investment opportunities, increases the capital stock from K_0 to K_1. However, for the firms which face high information costs, an increase in net worth leads to greater investment, all else being equal, while a decrease in net worth leads to lower investment.

Financing decisions should also be influenced by the attractiveness of future investment opportunities. They use Q to capture information about the value of long-term growth options in their baseline specification because accessing external funds may entail fixed costs; on the margin, the larger firms within a given subset of firms could be more favorably predisposed to substitute between internal and external funds due to economies of scale.

If information costs are high, profitable investment opportunities (measured by high value of q seen by firm insiders) may attract only very costly external financing. High information costs imply that an increase in Q does not bring forth the increase in investment predicted by the frictionless model. He argues that firm cash flow is an imperfect proxy for the

change in net worth because it represents a series of accounting decisions, reducing the correlation between cash flow and the change in net worth.

To identify a group of firms that are most likely to face binding financing constraints in which dividends are a residual in firm decision. When the adjustment cost of capital stock is higher than that the cost of adjusting dividends payout, paying dividends in the presence of promising investment opportunities with higher cost of external financing than internal financing is not consistent with value maximization. Therefore, if financing constraint are important, the investment of firms with good investment opportunities that retain all or nearly all of their earnings will likely be more sensitive to cash flow than for high-payout firms with a large (dividend) cushion of funds to finance investment.

This utilization of cash flow sensitivity is different from FAZZARI, HUBBARD and PETERSEN (1988)'s approach, it would be discussed in the following debates in chapter 2.4.3.

2.4.3 Investment - cash flow sensitiveness measure for financing constraints by KAPLAN and ZINGALES (1997) and sequential debates between FAZZARI, HUBBARD and PETERSEN (2000) and KAPLAN and ZINAGLES (2000)

KAPLAN and ZINGALES (1997) investigated the relationship between financing constraints and investment-cash flow sensitivities by analyzing the firms identified by FAZZARI, HUBBARD and PETERSEN (1988) as having unusually high investment-cash flow sensitivities. They find that firms that appear less financially constrained exhibit significantly greater sensitivities than firms that appear more financially constrained.

FAZZARI, HUBBARD and PETERSEN (1988) argue that the studies interpret a greater investment-cash flow sensitivity for firms considered more likely to face a larger wedge between the internal and the external cost of funds as evidence that the firms are indeed constrained. Cash flow may act as a *proxy* for investment opportunities not captured by Tobin's Q and do so differentially across firms. However, KAPLAN and ZINGALES (1997) argue that greater sensitivity of investment to cash flow is not a reliable measure of the differential cost between internal and external finance. In addition, FAZZARI, HUBBARD and PETERSEN (1988)'s higher dividend payout firms is explained by a relatively few company-years characterized by exceptionally high sales growth.

KAPLAN and ZINGALES (1997) classified firms by firm-years and classify first group as not financially constrained (NFC) group if the firm initiated or increased cash dividends, repurchased stock, or explicitly indicated in its annual report that the firm had more liquidity than it would need for investment in the foreseeable future. Likely not to be financially constrained (LNFC) firm-years the firms are healthy financially and do not give any indication of being liquidity constrained. These firms also tend to have sizable cash reserves, unused lines of credit, and healthy interest coverage. Either as financially constrained or as unconstrained (financially constrained (PFC)) which do not look particularly liquid either. Likely to be financially constrained (LFC) which have difficulties in obtaining financing. Generally, these firms are prevented from paying dividends and have little cash available. Undoubtedly financially constrained (FC) which are in violation of debt covenants, have been cut out of their usual source of credit, are renegotiating debt payments, or declare that they are forced to reduce investments because of liquidity problems.

Based on KAPLAN and ZINGALES (1997) classification into five sub-groups, 54.5 percent of firm-years are not financially constrained (NFC) and 30.9 percent of firm-years as likely not financially constrained (LNFC). Total of 85.4 percent of firm-years in which KAPLAN and ZINGALES (1997) find no evidence of financing constraints that restrict investment. KAPLAN and ZINGALES (1997) classify 7.3 percent of firm-years as possibly constrained, 4.8 percent as likely constrained, and 2.5 percent as definitely constrained for a total of only 14.6 percent firm-years in which there are the possibility of financing constraints.

Meanwhile, FAZZARI, HUBBARD and PETERSEN (2000) still insist that the usefulness of investment-cash flow sensitiveness for detecting financing constraint which is criticized by KAPLAN and ZINGALES (1997). In addition, FAZZARI, HUBBARD and PETERSEN (2000) argue that KAPLAN and ZINGALES (1997) theoretical model fails to capture the approach in their literature and thus does not provide an effective critique. FAZZARI, HUBBARD and PETERSEN (2000) also questioned the small and homogeneous sample of KAPLAN and ZINGALES (1997)[13]. FAZZARI, HUBBARD and PETERSEN (2000) do not accept the econometric treatment of the data, on which they claim to be able to troublesome. As a result, FAZZARI, HUBBARD and PETERSEN (2000) does not accept the criticisms of KAPLAN and ZINGALES (1997). They also conclude that the results presented

[13] HUBBARD (1998) also criticized this point in same manner.

by them are consistent with the presence of a financing constraint and, therefore, do not contradict the interpretation given by the previous studies.

FAZZARI, HUBBARD and PETERSEN (2000) argue that KAPLAN and ZINGALES (1997)'s empirical classification is flawed in identifying both whether firms are constrained and the relative degree of constraints across firm groups.

Thereafter, KAPLAN and ZINGALES (2000) initiated their contradiction as the subject of "Investment – cash flow sensitivities are not valid measure of financing constraints" and they emphasized their argument as follows;

> FAZZARI, HUBBARD and PETERSEN (2000) admit that financially distressed firms are likely to have lower investment-cash flow sensitivities than less financially constrained firms. This is exactly the point that the KAPLAN and ZINGALES (1997) model makes: investment-cash flow sensitivities are not necessarily monotonic in the degree of financing constraints. The only disagreement FAZZARI, HUBBARD and PETERSEN (2000) have with KAPLAN and ZINGALES (1997) is how pervasive the non-monotonicity result is. But this is ultimately an empirical question.

KAPLAN and ZINGALES (2000) disagree with FAZZARI, HUBBARD and PETERSEN (2000)'s criticism because FAZZARI, HUBBARD and PETERSEN (2000) questioned the validity of the KAPLAN and ZINGALES (1997)'s classification scheme based on a company's cash balances or unused lines of credit[14]. KAPLAN and ZINGALES (2000)'s argument is that FAZZARI, HUBBARD and PETERSEN (2000) claim that large amounts of these accounts indicate that a firm is taking the precaution of saving for fear of becoming constrained in the future. KAPLAN and ZINGALES (2000) criticize F FAZZARI, HUBBARD and PETERSEN (2000)'s logic should finally be induced a paradox that firms with more cash holdings are more financially constrained.

FAZZARI, HUBBARD and PETERSEN (1988) split the firms' financing constraints on the basis of the amounts of dividends paid. However, KAPLAN and ZINGALES (2000) again defend the impropriety of the use of the benchmark of dividends as a measure of financial constraint to determine the sensitivity of investments to cash flow. FAZZARI, HUBBARD and PETERSEN (2000)'s defense of investment-cash flow sensitivities as measures of financial constraints distracts attention from the more important question: what causes this sensitivity?

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[14] This classification criteria is consistent with financial flexibility measure by ARSLAN, FLORACKIS and OZKAN (2010); DEANGELO, GONÇALVES AND STULZ (2016).

KAPLAN and ZINGALES (2000) conjecture that the sensitivities are at least partially caused by excessive conservatism by managers, which may arise because of the way firms are organized internally or because of non-optimizing behavior by managers.

Anyhow, the debates between KAPLAN and ZINGALES and FAZZARI, HUBBARD and PETERSEN helps the researchers to review all the possible theoretical pitfall to generalize investment-cash flow sensitivity to classify financially constrained and unconstrained firms.

2.4.4 Financial flexibility measures by ARSLAN, FLORACKIS and OZKAN (2010); BANCEL and MITTOO (2011)

Financial flexibility ("FF" thereafter) is defined as preserving untapped borrowing power by MODIGLIANI and MILLER (1963) or unused debt capacities[15] which makes firm endurable from unexpected adverse exogenous shocks (BANCEL and MITTOO, 2004; BANCEL and MITTOO, 2011; DEANGELO and DEANGELO; 2007; GAMBA and TRIANTIS; 2008; MM 1963; MARCHICA and MURA, 2010).

According to ARSLAN, FLORACKIS and OZKAN (2010), financial flexibility appears to be an important determinant of investment and performance during the Asian crisis (1997-1998). They investigated the entire effects of financial crises on corporate investment (GAMBA and TRIANTIS, 2008; BYOUN, 2008, BYOUN, 2011). They also affirm that financial flexibility appears to be an important determinant of investment and performance. Firms which are financially flexible prior to this crisis have a greater ability to take investment opportunities; perform better than less flexible firms during the credit crisis period of 2007-2009. It is one of the most important determinants of their capital structure decision (GRAHAM and HARVEY, 2001; BANCEL and MITTOO, 2004; BROUNEN, DE JONG and KOEDIJIK, 2006)

ALMEIDA and CAMPELLO (2010); CLEARY (1999); CLEARY (2006); FAZZARI, HUBBARD and PETERSEN (1988); KAPLAN and ZINGALES (1997); HUBBARD (1998) dealt the relationship between corporate investment to the availability of internal funds and external funds under the classification with financing constraint criteria such as dividend

[15] High unused (spared) debt capacity (ALLEN, 2000; CLEARY 1999; MM, 1963; ROZEFF, 1982) which is known as "untapped borrowing power" has dominant determinant of financial flexibility.

payout and rating, size etc.[16] However, financing flexibility criteria *a priori* are not available as much as those of financing constraint.

BANCEL and MITTO (2011) utilized untapped borrowing power (MM, 1963) as a proxies for FF measure to examine its effect on capital structure and investment decisions (MARCHICA and MURA, 2010). However, BANCEL and MITTO (2011) doubt whether low leverage is an only adequate proxy for FF because some literature suggests that firms enhance their FF through other resources such as cash holdings (e.g. ALMEIDA and CAMPELLO, 2007). The most recent prevail determinants which classify firms as "financially flexible" is low leverage and high cash balances (ARSLAN, FLORACKIS and OZKAN, 2010; BYOUN, 2011; DEANGELO and DEANGELO, 2007; DEANGELO, GONÇALVES and STULZ, 2016; DENIS and MCKEON, 2012; GAMBA and TRIANTIS; 2008; MACHICA and MURA, 2010; KAPLAN and ZINGALES, 1997).

ARSLAN, FLORACKIS and OZKAN (2010) examined the impact of financial flexibility on the investment and performance of East Asian firms over the period 1994-2009 with the FF measure which high cash holdings and low leverage are the determinants for the classification of financially flexible firms. They employ a sample of 1068 firms and place particular emphasis on the periods of the Asian crisis (1997-1998) and the recent credit crisis (2007-2009) and the results present that firms can attain financial flexibility, primarily through conservative leverage policies and large cash balances. They find that the value of financial flexibility is region/country specific, which may be explained by the fact that different regions/countries often adopt different macroeconomic policies and operate in diverse economic/legal environments.

In BANCEL and MITTOO (2011)'s survey, some CFOs mentioned that the firm relies mostly on internal financing to preserve its borrowing power with the addition of banks lines of credit, and cash holdings. About the *size* which is the pervasive criteria to classify firms into financial constrained or unconstrained, BANCEL and MITTOO (2011) conducted a financial flexibility research whether French SMEs (small and medium enterprises) firms weathered the credit crunch better than large, publicly listed firms, however, SMEs are facing tough times as they have fewer assets and smaller cushions of retained earnings than big

[16] See table 2 of this thesis.

firms because they are unable to spread business risk by spreading across product lines and geographical areas.

For this thesis, the FF criteria of cash and leverage level is inserted to classify financially constrained firms and financially unconstrained firms because it is presumed that financing constraint status and FF have similar classification characteristic and also it is essential to compare the investment behaviors between crises and post-crisis .

2.5 Investment under crises

Firms can retain more profit by reducing payout during crisis (BODIE, KANE and MARCUS, 2014; BLISS et al., 2015) or pass up positive NPV project (MYERS, 1984; MYERS and MAJLUF, 1984), or sell their assets (CAMPELLO, GRAHAM, HARVEY, 2010) when they are unable to borrow during crisis (ALMEIDA and CAMPELLO; BANCEL and MITTO, 2011; ARSLAN, FLORACKIS and OZKAN, 2010; CAMPELLO, GRAHAM, HARVEY, 2010). According to BLISS et al. (2015), earnings are retained in response to a shock by a crisis. During 2008 and 2009 in the USA, 9.1% and 15.0% of dividend paying firms reduced their dividends per share.

CAMPELLO, GRAHAM, HARVEY (2010) examined how firms finance attractive investments when they are unable to borrow. More than half of U.S. firms say that they rely on internally generated cash flows to fund investment under these circumstances, and about four in ten say that they use cash reserves. According to them, 56% of constrained firms in U.S cancelled/postponed investment when they are unable to obtain external funds, whereas only 31% of unconstrained firms in U.S cancelled/postponed investment. They find largely similar patterns in Europe. Financially unconstrained firms fund investment mainly by cash flow / cash holdings in USA (0.55 / 0.46) and Europe (0.39 /0.40)[17], Their study reveals that funding sources of investment for both constrained firms and unconstrained firms are concentrate on cash flow and cash holdings. However, cancellation/postponement rates of both U.S. and Europe demonstrated double time differences between constrained firms and unconstrained

[17] This financially unconstrained firms' funding investment preference is consistent with financially flexible firm's criteria of high cash holding (ARSLAN, FLORACKIS and OZKAN, 2010; ; DEANGELO, GONÇALVES and STULZ, 2016)

firms. That is to say, constrained firms cancel more investments than unconstrained firms when external funds are not sufficient.

DUCHIN, OZBAS and SENSOY (2010), in their study of the effect of the financial crisis (initiating since August 2007) on corporate investment, find that corporate investment declines significantly following the onset of the crisis, controlling for firm fixed effects and time-varying measures of investment opportunities. They argue that theoretically negative shocks to the supply of external finance, together with the presence of financing frictions, might hamper investment opportunities if firms lack sufficient financial slack to fund all profitable investment opportunities internally.

2.6 Economic crises in Brazil

Each country suffers with crises of external indebtedness, crisis of internal indebtedness, inflation crisis, crisis of foreign exchange rate, local banking crisis, international banking crisis (CARVALHAL and LEAL, 2013; REINHART and ROGOFF, 2009) and the deterioration of economic growth (DE PAULA and ALVES Jr., 2000).

According to ZANI (2005), Brazil has long been considered an emerging country, and there are high investment opportunities for firms, however, has coupled with insufficient capital and entrepreneurial capacity to undertake them. CARVALHAL and LEAL (2013) argue that the world financial crisis initiated in 2008 have affected the international financing mix of Brazilian firms. For their investigation of the foreign financing mixes of Brazilian publicly traded firms before 2004 and during the 2008 world financial crisis, they find out that short-term financing and bank loans, domestic and foreign loan decreased in 2008 and were replaced by domestic and international bonds and American Depository Receipts (ADRs).

According to CORBETT and VINES (1999); FIDRMUC and KORHONEN (2010); RADELET and SACHS (1998), emerging countries such as BRICs (Brazil, Russia, India and China) and some Asian countries are known as “vulnerable” from global financial crises.

As demonstrate in Table 1, Asian Crisis in 1997 and 1998 was recognized as global crisis, Brazil suffered the local crisis due to political concern (insecurity) of initiation of LULA Government in 2002, and there were also local crisis from 2014 to 2016. Whereas, USA suffered with Global Financial Crisis triggered by Sub-prime mortgage which happened in 2007 and 2008, and Brazil suffered crisis in 2009 with the drop of GDR rate growth.

Table 1 Summary of adverse shocks which impact worldwide economy and Brazil

Country	Period	Description	Comments
Asia	1997-1998	Asian Financial Crisis	Financial crisis which transformed to a strong economic crisis, affecting countries in the Asian continent (Korea and Japan). This crisis generate global macroeconomic effect.
USA	2001	911 terrorist attack in New York	Short time Panic in Stock market
Brazil	2002	Local crisis in Brazil	This a crisis in function of initiation of LULA government (insecurity related to new government)
USA	2007-2008	Global Financial Crisis	Financial crisis of "subprime" USD, the importance event which turn into a grand economic crisis which have been example to promote an effect of global infection.
Brazil	2014-2016	Supply and demand crisis due to adoption of MNE 2011/2012	New Economic Matrix (MNE) reduced the productivity of the Brazilian economy and the potential product. Moreover, this supply shock has long-lasting effects due to the allocation of long-term investments in low-productivity sectors.

Source: BARBOSA-FILHO (2017); REINHART and ROGOFF (2008); KAPPEL (2017)

3 Hypotheses and procedure of methodology of the research

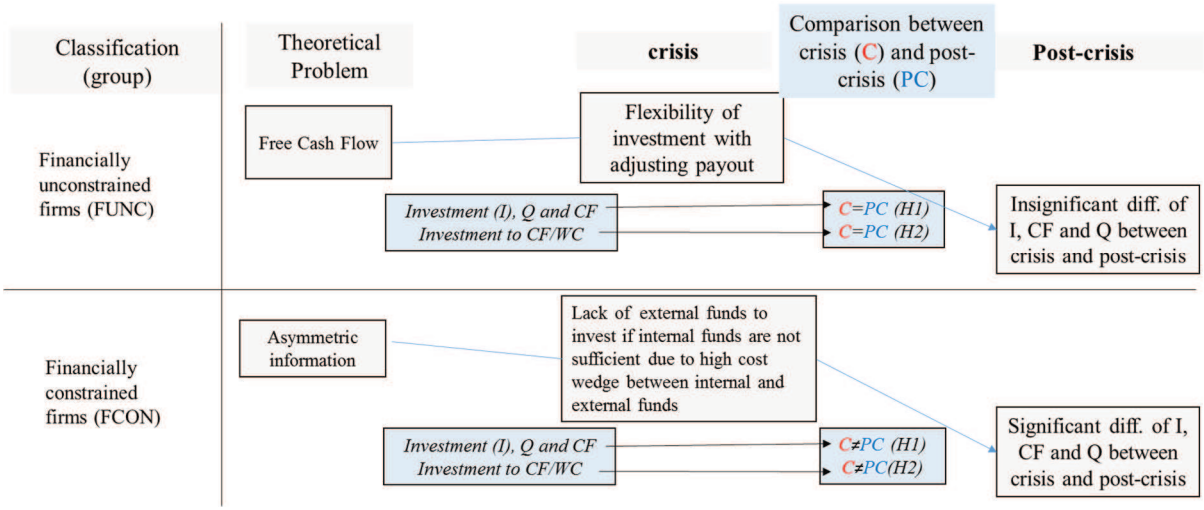
This part of the thesis presents the research hypothesis, methodological procedures and empirical strategy to test hypotheses, econometric procedures and expecting signs. Therefore, considering the proposed research problem, it is necessary to find the appropriate procedures to investigate empirically whether there are the differences of investments, growth opportunities and cash generations between crises and post-crises for Brazilian publicly traded firms, classifying firms based on financing constraint criteria.

For the preparation of the empirical tests, three specification procedures were required according to the configuration proposed in this thesis. Firstly, financing constraint criteria *a priori* were used to classify firms into constrained or unconstrained. Secondly, the identification of crises and post-crises period of Brazil were done. Thirdly, the justification of variables to be tested were defined. Finally, the appropriate methods of empirical test for each hypothesis were chosen to align with the objective of the research.

3.1 Testable hypothesis

Based on financing constraint status, the sample firms are classified as financially unconstrained (FUNC) or financially constrained (FCON). Figure 4 approaches from theoretical problems that how investment of each group (FUNC and FCON) can be differentiated with the existence of free cash flow for the investment during crisis. Financially unconstrained firms may have free cash flow (JENSEN, 1986) to disgorge, however, during crisis, it makes firms to be flexible to choose to payout more or less to reinvest (BODIE, KANE and MARCUS, 2014). Meanwhile, financially constrained firms are apt to suffer with asymmetric information which worsen their financial situation to result in the lack of funds to invest if internal funds are not sufficient due to high cost wedge between internal and external funds.

Figure 4 Hypotheses building based on theoretical problem



Investment= acquisition of PPE; CF= cash flow = EBITDA (Earnings before interest, taxes, depreciation and amortization); Q= ((total asset – total shareholders' equity) + Market Value) / total assets); PPE= acquisition of plant, property and equipment); WC = the change in working capital; diff. = difference.

Source: author

Hence, the differences of investment, growth opportunity (proxied by Q), cash generation, investment to cash flow sensitivity and working capital relation to investment between crisis and post-crisis are presumed to be statistically significant for financially constrained firms, while the differences of financially unconstrained firms are presumed not to be significant in Brazil.

H1. Effect of crisis comparing with post-crisis for financially constrained firms and unconstrained firms regarding investment, growth opportunities and cash generation

ARSLAN, FLORACKIS and OZKAN (2010) argue that economic and financial crises clearly represent exogenous shocks to firms' viability, profitability and cash flows, and they generally reduce the expected return on investment opportunities. According to them, including both crisis (Asian crisis, 1997-1998; Sub-prime Credit Crisis, 2007-2009) and post-crisis (Post Asian Crisis, 1999-2006), descriptive statistics for all firms (1994-2009) reveals that the mean of investment, cash flow and MTB (Q) of period 1997-2009 had remarkably dropped[18] comparing with pre-crisis (1994-96).

According to ARSLAN, FLORACKIS AND OZKAN (2010, p. 35), for the Low leverage and High Cash holding (LL-HC) firms in Asia, the investment (capital expenditure) to total assets was also dropped from 7.5% (p-value<0.1) to 4.7% (p-value<0.01) and Cash flow[19] was dropped from 12.3% (p-value<0.01) to 8.7% (p-value<0.01) between pre-crisis period (1994-1996) and Asian Crisis period (1997-98). Meanwhile, for high leverage and low cash (HL-LC) firms with same comparison periods, their investment to total assets was also dropped from 8.4% (p-value<0.1) to 3.6% (p-value<0.01) and cash flow to total assets was dropped from 8.1% (p-value<0.01) to 5.1% (p-value<0.01). This results reveals that, for less flexible firms or flexible firms, crises impact more on investment than cash flow, that is, both group of firms in Asia reduce more investment than cash flow comparing with pre-crisis and crisis. During the global financial crisis in 2008, CAMPELLO, GRAHAM, HARVEY (2010) find that the inability to borrow externally causes many firms to bypass attractive investment opportunities, 86% of constrained U.S. CFOs responded that their investment in attractive projects had been restricted due to difficulty in raising external finance, 44% of unconstrained firms had been.

Conjecturing the arguments by ARSLAN, FLORACKIS AND OZKAN (2010); CAMPELLO, GRAHAM, HARVEY (2010), it can be hypothesized that financially constrained firms suffer with underinvestment during crisis, hence, in the similar vein, it is

[18] For more detailed information, see ARSLAN, FLORACKIS and OZKAN (2010, p. 34) table 1.

[19] Operating income plus depreciation and amortization divided by total assets

assumed that financially constrained firms reduce more investment, growth opportunities and cash generation during crisis comparing with post-crisis in Brazil. However, financially unconstrained firm do not reduce more investment, growth opportunities and cash generation during crisis comparing with post-crisis in Brazil. Hence, the hypothesis 1(*H1*) are as below.

H1a: Financially constrained firms reduce more investment, growth opportunities and cash generation during crisis than post-crisis.

H1b: Financially unconstrained firms don't reduce investment, growth opportunities and cash generation during crisis comparing with post-crisis.

H2. Investment to cash-flow sensitiveness, working capital relationship to investment during crisis comparing with post-crisis

Regarding the firm's investment decision, it is known that high creditworthiness (least constrained) firms are very sensitive to the availability of internal funds (CLEARY, 1999; FAZZARI, HUBBARD and PETERSEN (1988); HUBBARD, 1998; KAPLAN and ZINGALES, 1997). As aforementioned in chapter 2.4.3, the debates between KAPLAN and ZINGALES and FAZZARI, HUBBARD and PETERSEN, the cash flow sensitivity has been controversial issue since the publication of the article by FAZZARI, HUBBARD and PETERSEN (1988). Cash flow is internal funds for the investment if this is not distributed to shareholders (BODIE, KANE and MARCUS, 2014).

VANCIN (2018) contends that Brazilian reality regarding low availability of long-term resources for the financing of firms is a great incentive for high cash retention by firms. That is to say, internal financing is the important determinants for the investment of Brazilian firms. However, there are minimum dividend obligation in Brazil. Hence, the legislation interferes with its investment policy. According to him, it is important to consider that Brazilian law removes part of the discretionary power of management in the choice of resources generated by the profit for the investments. Therefore, these institutional characteristics of Brazil may affect the empirical results of investment to cash flow sensitivity between crisis and post-crisis differently, especially for the firms which need pay out dividends in spite of the lack of internal

funds. This fact implies that financially unconstrained firms in Brazil can have the difference of investment to cash flow sensitivity due to minimum obligatory dividends payout between crisis and post-crisis. However, in spite of the distortion in investment due to obligatory minimum payout, this thesis maintains the position of insensitivity to investment of financially unconstrained firms as described in figure 4.

In addition, regarding the relationship between investment and working capital, FAZZARI and PETERSEN (1993) tested finance constraints on investment, their finding is that working capital and investment have negative relationship with fixed investment if both compete in a limited pool of finance. This study shed a light on the possibility that "limited pool of finance" is more severe for the firms with financing constraint during crisis comparing with post-crisis. However, it is presumed that financially unconstrained firms don't demonstrate such relationships which constrained firms have.

The hypothesis 2 (*H2)* are as below.

H2a: Financially constrained firms demonstrate more investment to cash-flow sensitivity during crises comparing with post-crises.

H2b: Financially unconstrained firms don't demonstrate more investment to cash-flow sensitivity during crises comparing with post-crises.

H2c: Financially constrained firms demonstrate more negative relationship between working capital and investment during crises comparing with post-crises.

H2d: Financially unconstrained firms don't demonstrate more negative relationship between working capital and investment during crises comparing with post-crises.

3.2 Methodological Procedures

This chapter presents methodological procedures about the definition and composition of the sample, data collection and treatment plan, the definitions and the measurements of the operational variables of this thesis.

3.2.1 Definition of Sample

Sample was collected from the database of ECONOMATICA® for the Brazilian firms. Initially, 690 publicly traded firms listed on BM&FBOVESPA (B3) with diverse sectors except financial institutes were collected. The reason why financial institutes were excluded from the sample is that this thesis postulates *investment accelerator* which acquisition of property, plant and equipment (i.e., investment) is positively related to growth of firm. Hence, this postulation does not fit for financial institutes and they are excluded from sample. After the eliminations of the firms which are mentioned below, the final sample were finally defined as 561 firms. The observation period is from 1998 to 2017.

This study utilized the twenty years period, with the use of panel data, providing a longitudinal amplitude with cross section. Thus, this study identified a cause and effect relationship between the variables comparing crises and post-crises periods which were defined by Brazilian statistics institute. Statistical software STATA/IC *version 14.2* was used to perform the appropriate empirical tests with the information which were collected by ECONOMATICA® based on the classification firms into financially constrained firms (FCON) and financially unconstrained firms (FUNC) *a priori*.

This study is based on quantitative evidences obtained by statistical procedures, since the objective is to analyze the data with the statistical significances. The representative qualified sample from total population is utilized to align with the objective of this thesis. As mentioned before, initial total sample was 690 firms with 13800 observations, and the following firms are eliminated from the sample:

- Firms' raw data set in ECONOMATICA® are not available (or *blank*) to calculate the variables in the equation or to classify the criteria of financing constraint (6099 observations);
- The information to calculate Tobin's Q were not available or sufficient (193 observations);
- The information to calculate IK were not available or sufficient (727 Observations);
- The information to calculate CFK data were not available or sufficient (1328 observations);
- Tobin Q's is greater than or equal to 10[20] (154 observations);

[20] DUCHIN, OZBAS and SENSOY (2010) excluded firms with Q above 10 from sample to handle outliers, following the alternative measure of BAKER, STEIN and WURGLER (2003).

- IK[21] is greater than or equal to 10 (74 observations);

$$Q\,t = \frac{\text{(Total asset – shareholders' equity + Market value of shares)t}}{\text{Total asset t}};\ CFK\ t = \frac{(\text{EBITDA})\text{t}}{(\text{Capital stock(K)})\text{t}-1};\ IK\ t = \frac{(\text{Acquisition of PPE}*)t}{(Capital\ stock\ (\text{K}))t-1}$$

*PPE = Plant, Property and Equipment

The justifications to eliminate the aforementioned firms in sample are the elimination of unavailable data or *outliers*, as well as to mitigate potential problems of measurement errors of Tobin's Q variable which is higher than ten (PORTAL, ZANI and SILVA, 2012). With these eliminations, the final sample is consist of 561 firms with 5225 observations for the classification of firms into financing constraint criteria *a priori.*

3.2.2 Operational definitions for empirical test strategy

To accomplish proposed empirical tests of the hypotheses of this thesis, firstly, it is necessary to classify total sample firms based on their financial constraint status *a priori* – financially constrained and financially unconstrained. Secondly, it is necessary to identify crises periods and post-crises periods of Brazil. To align with the objective of this study which is the comparison of variables between crises and post-crises, the definition of crises and post-crises periods with multiple years would be appropriate to observe the differences of investments, growth opportunities and cash generation between these two periods. Hence, this study refers the prior literature and the related chronicles of the institution. Finally, some adjustments were made to the crisis years which were already defined as crisis years by Brazilian statistics institutes.

3.2.2.1 Criteria of classification a priori into financially unconstrained (FUNC) and financially constrained (FCON) firms

To align with the objective of this study, comparison of investments, growth opportunities and cash generation between crisis and post-crisis by financing constraint status, it is necessary to classify the sample, *a priori*, based on the status of financial constraint - financially unconstrained and constrained. Table 2 demonstrates the criteria of prior literature for the reference to choose the appropriate criteria for this study. CALOMIRIS and HUBBARD (1993) argue that, in existing studies, low initial dividend payout ratios or small firm size are

[21] Because IK (investment / capital stock) are used as the dependent variable in the equation of this thesis, to avoid the mismatch with Q (see footnote 22), IKs over 10 were eliminated.

typically used as proxies for high costs of external finance which increases cost wedge against internal funds. According to LAMONT et al. (2001), *financially constrained* means that the firm is not able to fund all the project it wants to. However they think *financing constrained* doesn't mean financial stress, economic stress and bankruptcy risk, although these things may be correlated with financial constraint.

Table 2 Criteria of classification of firms based on firm's financial constraint

Author(s)	Year	Journal	Subject	Countries	Period	No. of firms	Payout	Size	ADR	Bond rating	Rating paper	Leverage	KZ index	WW* index	Age
FHP88	1988	Brooking papers on Economic Activity	Financing constraints and Corporate investment	USA	1970-1984	422	v								
GILCHRIST and HIMMELBERG	1995	Journal of Monetary Economics	Evidence on the role of cash flow for investment	USA	1979-1989	428	v	v		v	v				
KAPLAN and ZINGALES	1997	Quarterly Journal of Economics	Do investment cash-flow sensitivities provide useful measures of financing constraints:	USA	1970-1984	49	v								
CLEARY	1999	Journal of Finance	The relationship between firm investment and financial status	USA	1988-1994	1317	v								
ALMEIDA, CAMPELLO and WEISBACH	2004	Journal of Finance	The cash flow sensitivity of cash	USA	1971-2001	1080	v	v		v	v		v		
ZANI	2005	Doctoral thesis in UFRGS	Estrutura dde capital : Restrição Financeira e sensibilidade do Endividament em relação ao colateral	BRAZIL	1990-2003	436	v	v	v			v			
ARSLAN, FLORACKIS and OZKAN	2006	Emerging Markets Reivew	The role of cash holdings in reducing investment–cash flow sensitivity	TURKEY	1998-2002	220	v	v							v
DUCHIN, OZBAS, SENSOY	2009	Journal of Financial Economics	The effect of the recent financial crisis on corporate investment	USA	2006-2008 (by quarter)	3668	v	v		v			v	v	
ALMEIDA and CAMPELLO	2010	Journal of Financial and Quantitative Analysis	Financing frictions and the Substitution between Internal and External funds	USA	1971-2001	1080	v	v		v	v				
CAMPELLO, GRAHAM, HARVEY	2010	Journal of Financial Economics	The real effects on financial constraints: evidences from a financial crises	USA, EUROPE, ASIA	2008 (by quarter)	1050	v	v		v					
HADLOCK and PIERCE	2010	The Review of Financial Studies	New Evidence on Measuring Financial Constraints: Moving Beyond the KZ Index	USA	1995-2004	356		v					v **	v **	v
PORTAL, ZANI and SILVA	2012	Revista Contabilidade e Finança - USP	Fricções financeira e a substituição entre funds internos e externos em companhias brasileiras de capital aberto	BRAZIL	1995-2005	326	v	v	v						
KAPPEL	2017	Doctoral thesis in UNISINOS	Decisão de investimento: Impactos da restrição financeira e das crsis econômicas	BRAZIL	1995-2015	661	v	v	v						

** Whited and Wu (WW, 2006) index[22]; ** KZ index[23] and Whited Wu indexes are used for the comparison and alternative indexes for financial constraints, respectively.*

Source: elaborated by author referring KAPPEL (2017)

[22] WW index = - 0.091CF - 0.062DIVPOS + 0.021*TLTD - 0.044*LNTA + 0.102*ISG - 0.035*SG; where, TLTD is the ratio of the long-term debt to total assets; DIVPOS is an indicator that takes the value of one if the firm pays cash dividends; SG is firm sales growth; LNTA is the natural log of total assets; ISG is the firm's three-digit industry sales growth; CASH is the ratio of liquid assets to total assets; CF is the ratio of cash flow to total assets (re-written by DUCHIN, OZBAS and SENSOY (2010); -0.091*Cash Flow + 0.062*Dividend Dummy + 0.021*Long Term Debt –0.044*Size + 0.102*Industry Sales Growth – 0.035*Sales Growth).

[23] The KZ index = -1.002*Cash Flow + 0.283*Q + 3.319*Debt – 39.368*Dividends – 1.315*Cash (LAMONT et al., 2001; DUCHIN, OZBAS and SENSOY, 2010).

Comparing with the definition of financial flexibility (BANCEL and MITTOO, 2011) that is the ability of a firm to respond effectively to unanticipated exogenous shocks to its cash flows or its investment opportunities, the main difference from financing unconstraint is the endurability of unexpected exogenous shocks (crisis).

High cash and low leverage (ARSLAN, FLORACKIS and OZKAN, 2010; BYOUN, 2011; DEANGELO and DEANGELO, 2007; DEANGELO, GONÇALVES and STULZ, 2016; DENIS and MCKEON, 2012; GAMBA and TRIANTIS; 2008; MACHICA and MURA, 2010; KAPLAN and ZINGALES, 1997) is frequently utilized criteria to classify the financial flexibility of a firm. Therefore, this study newly added one of the financial flexibility criteria into the traditional financial constraint classification criteria such as payout, size and age.

The classification criteria by financing constraint with payout and firm size (GILCHRIST and HIMMERBERG, 1995; ALMEIDA, CAMPELLO and WEISBACH, 2004, ACHARYA, ALMEIDA and CAMPELLO, 2007; ALMEIDA and CAMPELLO, 2010; PORTAL, ZANI and SILVA, 2012; ARSLAN, ARSLAN, FLORACKIS and OZKAN, 2010 HADLOCK and PIERCE, 2010; DUCHIN, OZBAS and SENSOY, 2010) are generally accepted for the previous studies.

HADLOCK and PIERCE (2010) suggest the proxy of firm size and age to predict financing constraints. According to them, these two variables that do appear to offer additional explanatory power for predicting constraints as cash flow and leverage do. However, due to their concerns about the endogeneity of leverage and cash flow, they advocate a conservative approach that uses only firm size and age to measure financial constraints.

According to Brazilian studies (COSTA and PAZ, 2004; PORTAL, ZANI and SILVA, 2012), applying each criteria separately have failed to achieve the theoretical results. Therefore, this research use the intersection of two proxies for the classification of financing constraint.

The three classification criteria have intersection of two proxies as follows.

- ✓ **Payout and Size (intersection of both criteria)**

This method is an intersection between the size and payout for the classification of financing constraint (KAPPEL, 2017; PORTAL, ZANI and SILVA, 2012; PORTAL, ZANI and SILVA, 2013). For the classification of firms by payout, the firms were classified by annual *payou*t, that is, the amount of dividends and interest on capital paid annually, divided by the

net income of the period (FAZZARI, HUBBARD and PETERSEN, 1988, GILCHRIST and HIMMERLBER, 1995; ALMEIDA and CAMPELLO, 2001; PORTAL, ZANI and SILVA, 2012; PORTAL, ZANI and SILVA, 2013; KAPPEL, 2017).

FAMA and FRENCH (2002) argue that the lowest dividend payment can be associated with difficulties in accessing external sources of financing. According to PORTAL, ZANI and SILVA (2012), in Brazil, a negative relationship has been observed between growth opportunities and payout (FUTEMA, BASSO and KAYO, 2009; IQUIAPAZA, AMARAL and LAMOUNIER, 2008).

ZANI (2005) used the classification of payout criteria, for the firms pay out more than 25%[24] as FUNC (financially unconstrained firms) and the firms pay out less than or equal to 25% as FCON (financially constrained firms). Whereas, PORTAL, ZANI and SILVA (2012); PORTAL, ZANI and SILVA (2013) defined FUNC and FCON as follows: The firms that did not pay annual dividends or interest on capital and that did not make any repurchases were classified as financially constrained. Among the firms that submitted a *payout* greater than zero, the firms of the bottom three deciles of the distribution were considered financially constrained firms, whereas the firms of the top three deciles were classified as financially unconstrained.

Firm size is frequently used proxy for researchers which dealt with the classification of firms with the status - financially constrained or unconstrained. Because the bigger orgainization, the more possibility to obtain the financing for the investment opportunity (VIJVERBERG, 2004). CAMPELLO, GRAHAM, HARVEY (2010) split the firms into small and large categories according to sales revenue. ALMEIDA and CAMPELLO (2001); ALMEIDA, CAMPELLO and WEISBACH (2004); ACHARYA, ALMEIDA and CAMPELLO (2007); ALMEIDA and CAMPELLO (2010); PORTAL, ZANI and SILVA (2012) argue that reduction of credit rationing of firms happen according to increase of firm size (GILCHRIST and HIMMELBERG, 1995; ALMEIDA, CAMPELLO and WEISBACH, 2004; ZANI, 2005; PORTAL, ZANI and SILVA,2012). According to 88, during downturns, large firms have greater relative access to short-term and long-term debt markets. Hence, if internal

[24] According to PORTAL, ZANI and SILVA (2012), the Brazilian recent law 10303/01 (October 2001) permits that there is a possibility for a firm to pay dividends less than 25% of the adjusted net income. Therefore, the firms with zero payouts may be separated because, otherwise, some companies with this characteristic or with less than 0.25 payouts could be classified as unconstrained. However, no firms classified as *unconstrained* in this thesis presented the payout of less than 25% of their net income.

and external sources of funds are not perfect substitutes, business recessions affect internal finance and have a greater effect on the growth rates and investment behavior for small, immature enterprises.

To measure the firm size annually in a more robust way, this research adopted not only the logarithm of the value of total assets, but also the logarithm of sales revenue. These two variables are summed and divided by two on annual bases. Top one-third of total sample will be classifed as unconstrained firms, bottom one-third as constrained firms.

PORTAL, ZANI and SILVA (2012) chose only the firms that presented the same state in both criteria were classified as constrained or unconstrained. Therefore, the classification of FUNC (financially unconstrained firms) are annually classified with unconstrained by both size and payout criteria. They used the intersection between the observations of the firms classified according to the criteria of *size* and *payout*. In other words, only the firms that presented the same state in both criteria were classified as FUNC or FCON.

The intersection of size and payout to classify firms into FCON and FUNC as follows:

> * High *Payout* and Big *Size* (**HP-BS**) as FUNC = firms which demonstrated both criteria in same state, that is, top one-third of size (net sales and total asset) and top one-third of sample payouts more than zero on annual base.
>
> * Low *Payout* and Small *Size* (**LP-SS**) as FCON = firms which presented both criteria in same state. Bottom one-third of size (net sales and total asset) and, for the payout criteria, firms didn't pay payouts, among the firms that presented payout more than zero, the firms of the bottom one-third of sample in annual base (PORTAL, ZANI and SILVA, 2012; PORTAL, ZANI and SILVA, 2013).

- ✓ **Cash holding and leverage(intersection of both criteria)**

BANCEL and MITTO (2011) note that cash holding, leverage and bank credit lines are likely to vary across firms and it makes difficult to quantify financial flexibility and they use qualitative method (CFO survey) to fulfill their study.

Meanwhile, ARSLAN, FLORACKIS and OZKAN (2010) tried an intersection of the two proxies of high (low) cash holdings and low (high) leverage as a proxy to classify financially flexible firms (less financially flexible) for the empirical tests. Division of sample

firms into sub-groups on the basis of their cash and leverage[25] positions. They generate four subsamples of firms: (1) low leverage; (2) high leverage; (3) low cash; and (4) high cash firms. Additionally, they identify two further groups of firms; (5) low leverage and high cash (LL-HC); and (6) high leverage and low cash (HL-LC) firms considering both policies simultaneously with the cut-off points of the 25th and the 75th percentiles.

According to the authors, a number of studies have emphasized the importance of obtaining financial flexibility through low leverage policies (BILLET, KING and MAUER, 2007; BYOUN, 2008; and CAMPELLO, GGH2010) or moderate/high cash balances (OPLER et al., 1999; ALMEIDA, CAMPELLO and WEISBACH, 2004; ACHARYA, ALMEIDA and CAMPELLO, 2007). The main argument of both policies is that firms with large cash balances or low leverage can better cope with earnings shortfalls and hence they can avoid underinvestment. BYOUN (2008) reports that small developing firms are more likely to seek financial flexibility and do so through lower leverage and larger cash holdings policies.

However, HADLOCK and PIERCE (2010) have a difference view of high cash because a firm can hold a high level of cash and it may be an indication that the firm is constrained and is holding cash for precautionary reasons. On the other hand, BATES, KAHLE and STULZ (2009) argue that high cash holdings are related to low levels of debt and hence the simultaneous practice of these policies enable firms to overcome distress and default.

Hence, this research includes two variables to measure financing constraint of firms as follows.

> * High Cash holding and Low Leverage (**HC-LL**) as FUNC = Top one third of cash holdings and bottom one third of leverage ratio, that is, firms that have their cash to total asset ("cash ratio") lying in the top one-third of the cash ratio distribution, and also their total debt to total assets ("leverage ratio") lying in the bottom one-third of the leverage ratio distribution;
>
> * Low Cash holding and High leverage (**LC-HL**) as FCON = bottom one third of cash holdings and top one third of leverage ratio, that is, firms that have their

[25] Leverage is the ratio of total debt to total assets. Cash is the ratio of cash, cash equivalents and short-term securities to total assets.

cash ratio lying in the bottom one-third of the cash ratio distribution, and also their leverage ratio lying in the top one-third of the leverage ratio distribution.

- ✓ **Size and age (intersection of both criteria)**

The empirical evidence of CLEMENTI and HOPENHAYN (2006) demonstrate that as age and size increase, mean and variance of growth decrease and also the sensitivity of investment to cash-flows declines. GERTLER and GILCHRIST (1994); GILCHRIST and HIMMELBERG (1995) find that the sensitivity of investment to cash-flow is higher for smaller and younger firms. In the general discussion part of FAZZARI, HUBBARD and PETERSEN (1988), they confess that some participants suggested that the authors should have grouped the firms according to some exogenous characteristic such as size or age rather than by their dividend-income ratio. It is not sufficient to argue that all high dividend firms are small or young, because a considerable percentage of the small and young firms might be in low dividend payout firms.

According to ARSLAN, FLORACKIS and OZBAS (2006), smaller firms are more likely to be financially constrained as they are subject to greater asymmetric information and agency problems. Therefore, financially constrained firms have difficulties in accessing external finance. Whereas, older firms have an established reputation in the market, which facilitates their access to external finance, mainly because their relationships with creditors are settled within a longer time span (BERGER and UDELL, 1995).

HADLOCK and PIERCE (2010) develop SA (size and age) index[26] when they tried to find out the substitution of KZ index as the classification measure of financing constraint. This SA index indicates that financial constraints fall sharply as young and small firms start to mature and grow. They also argue that appealing feature of these variables is that they are much less endogenous than most other sorting variables. Their justification is that this evidence increases the confidence in the SA index as a reasonable measure of constraints.

The composition of size and age variable to classify financing constraints are as follows.

[26] SA index is calculated as $(-0.737 * \text{Size}) + (0.043 * \text{Size}^2) - (0.040 * \text{Age})$, where Size equals the log of inflation-adjusted book assets, and Age is the number of years the firm is listed with a non-missing stock price on COMPUSTAT (HADLOCK and PIERCE, 2010).

- Big Size and Old Age (**BS-OA**) as FUNC = if a firm presents top one-third of the sample based on the sum of total assets and revenue, at the same observation period, it also presents top one-third[27] of age (based on older foundation year[28]) of the sample;

- Small Size and Young Age (**SS-YA**) as FCON = if a firm is in bottom one-third of the sample based on total asset size and revenue, at the same observation period, it also presents bottom one-third of age (based on older foundation year) of the sample.

3.2.2.2 Identification of crises and post-crises in Brazil

Crises are recurring events with various degrees of severity, which stimulate the cost wedge between internal funds and external funds for the firms with high information asymmetry, and it promotes greater interdependence of investment and financing decisions (DUCHIN, OZBAS and SENSOY, 2010; CARVALHAL and LEAL 2013).

To investigate these relations throughout crises, it is important to define the crises and post-crises periods appropriately to align with the objective of the research.

3.2.2.2.1 Duration of crisis and post-crisis period in previous literature

To classify crises and post-crises, it is necessary to refer to previous literature how long crisis and post-crisis[29] have lasted. For example, LEE, PARK and SHIN (2009) defined the Asian Financial Crisis (1997 to 1998) and the post-crisis sample period is from 1999 to 2005 (seven years) in their examination how the onset of a financial crisis affects the operation of internal capital markets in Korea. ARSLAN, FLORACKIS and OZKAN (2010) divide the

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[27] ARSLAN et al. (2006) classify the financial constrained (unconstrained) group those firms whose age lies below (above) the median age value in the age distribution. This thesis take one-third of top and bottom for the classification.

[28] HADLOCK and PIERCE (2010) define age as (number of years the firm is public), however, this study used the foundation year of each firm to classify financing constraint. ARSLAN et al. (2006) assign to the financial constrained (unconstrained) group those firms whose age lies below (above) the median age value in the age distribution.

[29] A part of post-crises can also be another pre-crisis period of the next crisis, however, this research assumes the repetition of crisis and post crisis cycle to compare the indexes between them.

crises periods as four panels; Pre-Asian Crisis period (1994-1996), Asian crisis period (1997-1998), post Asian crisis (1999-2006) and Credit Crisis Period (2007-2009).

Based on yearly crisis classification in Brazil with CODACE30, it is necessary to classify crisis and post-crisis periods to compare the differences of investments, growth opportunities and cash generation between two periods. The following chapter adjusts and defines these two periods based on current official classification of crises in Brazil.

3.2.2.2.2 Definition of crises and post-crises periods in Brazil

According to REINHART and ROGOFF (2008), the different financial crises are usually associated with factors such as the transition from an emerging or developing economy to a more advanced economy. The deterioration of economic growth, bank crises, strong fluctuations in exchange rate, and inflation happen thereafter.

Table 3 classifies the expansion and recession of Brazilian economy by the quarterly basis based on GDP rate growth rate. Brazil had suffered with Brazilian currency (*Real*) crisis from 1998 to 1999 (DE PAULA and ALVES, Jr., 2000). It explains that increasing fragility during the *Real* Plan left the country quite vulnerable to changes at the international level.

Table 3 Quarterly Chronology of the Brazilian Business Cycles – CODACE

Chronology of the Brazilian business cycle - duration and amplitude									
Recessions					Expansions				
Period		Duration (quarters)	Growth (%) accumulated peak to valley	Growth (%) quarterly Average	Period		Duration (quarters)	Growth (%) accumulated peak to valley	Growth (%) quarterly Average
From	To				From	To			
1Q 1981	1Q 1983	9	-8.5%	-3.9%	2Q 1983	2Q 1987	17	30.0%	6.4%
3Q 1987	4Q 1988	6	-4.2%	-2.8%	1Q 1989	2Q 1989	2	8.5%	17.7%
3Q 1989	1Q 1992	11	-7.7%	-2.9%	2Q 1992	1Q 1995	12	19.2%	6.0%
2Q 1995	3Q 1995	2	-2.8%	-5.6%	4Q 1995	4Q 1997	9	8.0%	3.5%
1Q 1998	1Q 1999	5	-1.6%	-1.3%	2Q 1999	1Q 2001	8	7.3%	3.6%
2Q 2001	4Q 2001	3	-0.8%	-1.1%	1Q 2002	4Q 2002	4	5.3%	5.3%
1Q 2003	2Q 2003	2	-1.3%	-2.6%	3Q 2003	3Q 2008	21	30.0%	5.1%
4Q 2008	1Q 2009	2	-6.2%	-11.9%	2Q 2009	1Q 2014	20	22.8%	4.2%
Since 2Q 2014									

Q = Quarter.

Source: CODACE's meeting result published at 30 July 2015

[30] Comitê de Datação de Ciclos Econômicos

Also, Sub-prime Credit crisis in U.S. (from 2007 to 2008[31]) impacts Brazil in 2009. 2014-2016 crisis was not mentioned on table 3, however, at the meeting on October 27, 2017, CODACE identified that crisis had lasted 11 quarters from the second quarter of 2014 and the fourth quarter of 2016 (BARBOSA-FILHO, 2017). According to BARBOSA-FILHO (2017), the accumulated loss of Gross Domestic Product (GDP) in these 11 quarters was 8.6% based on data from Brazilian Institute of Geography and Statistics (IBGE)[32].

The justification to choose the observation period of crises (from 1998 to 2017, 20 years) for this research is that because worldwide crises have been recurring since 1997 Asian crisis and Brazil had been (2014 to 2016) suffered from economic crisis. For the comparison of crisis and post-crisis, this research modified the definition of crisis and post-crisis period with the compositions of multiple years for each crisis and post-crisis such as figure 5.

Table 4 Summary of external negative shocks in Brazil

Country/ Origin	Period	Type of crisis	Description / Comments
Brazil	1994	Financial crisis	Bank crisis
Brazil	1995	Financial crisis	Bank crisis
Brazil	1995	Financial crisis	Inflation crisis
Brazil	1995	Economic crisis	CODACE - dating synthesis
Brazil	1996	Financial crisis	Bank crisis
Asia	1997	Other crisis	Asian financial crisis
Asia	1998	Other crisis	Asian financial crisis
Brazil	1998	Economic crisis	CODACE - dating synthesis
Brazil	1999	Financial crisis	Foreign exchange crisis
Brazil	1999	Economic crisis	CODACE - dating synthesis
USA	2001	Other crisis	911 Terrorist Attack
Argentina	2001	Other crisis	Foreign exchange crisis
Brazil	2001	Economic crisis	CODACE - dating synthesis
Brazil	2002	Other crisis	Initiation of Lula Government
Brazil	2003	Economic crisis	CODACE - dating synthesis
USA	2007	Other crisis	USA subprime financial crisis
USA	2008	Other crisis	USA subprime financial crisis
Brazil	2008	Economic crisis	CODACE - dating synthesis
Brazil	2009	Economic crisis	CODACE - dating synthesis
Brazil	2014	Economic crisis	CODACE - dating synthesis
Brazil	2015	Economic crisis	CODACE - dating synthesis
Brazil	2016	Economic crisis	CODACE - dating synthesis

CODACE = Comitê de Datação de Ciclos Econômicos

Source: KAPPEL (2017)

[31] ARSLAN, FLORACKIS and OZKAN (2014) define credit crisis period as from 2007 to 2009. They also define post-Asian crisis from 1999 to 2006 considering this credit crisis period which starts from 2007

[32] Instituto Brasileiro de Geografia e Estatística

Comparing with the table 3 and table 4, the justification for the eliminations of year 2001 and year 2003 from crisis periods on figure 5 is that because the drop of GDP growth rate during that period were less than other crisis period (-0.8% and -1.3% respectively, column *"growth (%) accumulated peak to valley"*). In addition, the reason why the year 2008 is excluded on figure 5 from crisis period is that BACEN (Central Bank of Brazil) confirms annual four per cents of GDP growth rate in 2008 (whereas, in 2009, annual GDP growth rate was -1.1%). After adjusting these three years from crisis to post-crisis, finally, binary classifications of crisis and post-crisis for this research were completed as figure 5.

Figure 5 Classification of multiple years of crisis and post crisis applied for this thesis

Source: author

3.2.3 Justification of variables

This section presents the formula and justifications of using the variables and selected for the equations in regression models and the comparison of differences of variables between crises and post-crises for this thesis. The components to calculate variables are obtained by ECONOMATICA® for Brazilian publicly traded firms. To choose the appropriate variables for the study, it is necessary to see related variables to similar theme of this research. The table 5 demonstrates the variables in the regression models to relate corporate investment with financing constraint, most of the previous literature followed FAZZARI, HUBBARD and PETERSEN (1988)'s reduced form investment equation model which defines dependent variable as "investment" during the year (I_t) deflated by beginning balance of capital stock of the year (K_{t-1}) except ARSLAN, FLORACKIS and OZKAN (2006, 2010) who used denominators as lagged total assets. The most frequent explanatory variables which relate corporate investment are cash flow deflated by lagged capital stock (CFK) and Q. This research add the variable of *size* (GILCHRIST and HIMMELBERG, 1995; ALMEIDA, CAMPELLO and WEISBACH, 2004; ZANI, 2005: ACHARYA, ALMEIDA and CAMEPELLO, 2007; DUCHIN, OZBAS and SENSOY (2010; KAPPEL, 2017) for the regression. This study adds

working capital as explanatory variable which is known as competing with investment within limited pool of finance (FAZZARI and PETERSEN, 1993).

Finally, the variables both for comparison test and regression model are based on FAZZARI, HUBBARD and PETERSEN (1988)'s reduced-form equation model, and *change of working capital* (FAZZARI and PETESEN, 1993) is added as an explanatory variable, and *size* as the control.

Table 5 Explanatory variables in regression models to relate corporate investment with financing constraint

Authors	Year	Country	Subject	Dependent variable	Explanatory variables				
					CF	Q (MTB)	SIZE	Tangibility	ΔW/K
FAZZARI, HUBBARD and PETERSEN	1988	USA	Financing Constraint and Corporate Investment	Investment (I/K)	v	v			
FAZZARI and PETERSEN	1993	USA	Working capital and fixed investment: New evidence on financing constraints	Investment (I/K)	v	v			v
KAPLAN and ZINGALES	1997	USA	Do financing constraints explain why investment is correlated with cash flow?	Investment (I/K)	v	v			
CLEARY	1999	USA	The relationship between firm investment and financial status	Investment (I/K)	v	v			
ALMEIDA and CAMPELLO	2007	USA	Financial constraints, asset tangibility, and corporate investment	Investment (I/K)	v	v		v	
ARSLAN, FLORACKIS and OZKAN	2006	Turkey	The role of cash holdings in reducing investment–cash	Investment (I/A)	v	v			
KAPPEL	2017	Brazil	Decision of investment: Impact of financial constraint and of economic crises	Investment (I/K)	v	v	v		
ARSLAN, FLORACKIS and OZKAN	2010	East Asia	Financial flexibility, corporate investment and performance: evidence from financial crisis	Investment (I/A)	v	v			

***Tangibility** = the ratio of tangible assets to total assets: **I**= capital expenditure during the year; **K**= the beginning of accounting balance of capital stock; **A** = total asset of year-end.; ARSLAN, FLORACKIS and OZBAS (2010) used the regression model for their study of financial flexibility.*

Source: author

The followings demonstrate how to calculate each variables.

1) **Tobin's *Q* (to measure growth opportunity of a firm)**

$$Q\ t = \frac{(\text{Total asset} - \text{shareholders' equity} + \text{Market value of shares})\ t}{\text{Total asset}\ t};$$

ZANI (2005) argues that investment opportunity is a proxy normally represented by Tobin's Q or by related market value of firm divided by the accounting book value (KAPLAN and ZINGALES 1997; DUCHIN, OZBAS and SENSOY, 2010: PORTAL, ZANI and SILVA, 2012). However, in Brazil, some studies (HAMBURGER, 2004; TERRA, 2003) revealed that the limitation of these variables such as Tobin's Q. FAZZARI, HUBBARD and PETERSEN (1988) included Q in their reduced-form equation model because Q is based on asset prices determined in forward-looking markets, it should capture the prospective profitability of investment better than lags of past profits. Their results demonstrated that including Q reduces the cash flow effect somewhat in low dividend payout (financially constrained firms). To measure future investment opportunities, HUBBARD (1998) uses Q to capture information about the value of long-term growth options (ARSLAN, FLORACKIS and OZKAN, 2006; ARSLAN, FLORACKIS and OZKAN, 2010). FAZZARI, HUBBARD and PETERSEN (1988) note Q[33] that emphasize market valuations of the firm's assets as the determinant of investment, and neo-classical models combine measures of output and the cost of capital to explain investment demand (FAZZARI and PETERSEN, 1993).

However, CUMMINS, HASSETT and OLINER (2006)'s results strongly caution against using Tobin's Q to estimate investment models. Firstly, Tobin's Q is a noisy control for fundamentals; only the portion that is correlated with the firm's past performance or its expected earnings helps to explain investment spending. Regarding the relationship between investment and Q in financially constrained firms, CHIRINKO (1995) argues that the effects of financing constraints will be fully reflected in a firm's market value (Q). KAPLAN and ZINGALES (1997) argue that Q is not sufficient to explain the investment of financially constrained firms. For reduced form investment equation models, Q which is market value of

[33] According to FAZZARI, HUBBARD and PETERSEN (1988), Q is the sum of the value of equity and debt less the value of inventories, divided by the replacement cost of the capital stock adjusted for corporate and personal taxes

firm plus total liabilities (total asset minus shareholders' equity) divided by total asset (PORTAL, ZANI and SILVA, 2012; (PORTAL, ZANI and SILVA, 2013: KAPPEL, 2017) is commonly utilized in Brazil, and this study adopted it.

2) Cash flow

$$\text{CF } t \text{ /K } t\text{-}1 = \frac{(\text{EBITDA})\text{t}}{\text{Capital stock(K)t}-1} ;$$

DUCHIN, OZBAS and SENSOY (2010); ZANI (2005) define that cash flow represents the internal funds generated and available for investment allocations which is measured as EBITDA[34] divided by total Asset. FAZZARI, HUBBARD and PETERSEN (1988) note that cash flow represents the potential sensitivity of investment to fluctuations in available internal finance after investment opportunities. According to GERTLER and HUBBARD (1988), cash flow shocks matter more for investment during downturns of the business cycle. ARSLAN, FLORACKIS, OZKAN (2010) regard cash flow as a *proxy* for the availability of internal sources for investment which was referred by FAZZARI, HUBBARD and PETERSEN (1988).

HUBBARD (1998); GOYAL and YAMADA (2004) argue that, if cash flow is correlated with expected investment opportunities, cash flow may turn out to be a significant explanatory variable in the investment regression. According to ZANI (2005), the numerator "EBITDA" represents the generation of internal funds against operation. This index represents real firms' capability of payment. The higher it is, the greater the financial capacity of the firm. GILGHRIST and HIMMELBERG (1995) find that cash flow is an independent "fundamental" variable explaining investment.

Firm's internal cash flow (CF) represents the potential sensitivity of investment to fluctuations in available internal finance (FAZZARI, HUBBARD and PETERSEN, 1988). According to FAZZARI and PETERSEN (1993), when cash flow (CF/K) relates to investment (I/K), the coefficient of low-dividend firms[35] (0.743) is more sensitive than that of high-dividend firms (0.299) when high-dividend firms are defined as which pay more than 20% of their income as dividends in most years.

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[34] Earning Before Interests, Taxes, Depreciation and Amortization

[35] FAZZARI and PETERSEN (1993) focus on the behavior of firms that pay virtually no dividends because they most likely to face financing constraint. According to them, in the June 1991 COMPUSTAT database, 56% of the manufacturing firms paid no dividends in 1990 and also rarely make use of new equity finance.

This variable uses EBITDA divided by lagged K (capital stock t-1) which was utilized by FAZZARI, HUBBARD and PETERSEN (1988); FAZZARI and PETERSEN (1993).

3) Corporate Investment (acquisition of PPE[36])

I (Corporate Investment) t / K t-1 $= \frac{(\text{acquisition of PPE}*)t}{Capital\ stock\ (\text{K})t-1}$ *PPE = Plant, Property and Equipment

According to MODIGLIANI and MILLER (1963)'s *footnote 3* (p. 434), regarding expected return with cash flow and EBIT (earnings before interest and tax), assets have finite lives as soon as these assets attain a steady state age distribution in which annual replacements equal annual depreciation. The finite lives of asset is cut off rate for investment decision. Most literature define investment as the ratio of capital expenditures (PPE) to beginning-of-period capital stock, that is, $\frac{(\text{I})t}{(\text{K})t-1}$ (FAZZARI, HUBBARD and PETERSEN, 1988; KAPLAN and ZINGALES, 1997; Cleary, 1999; ALMEIDA and CAMPELLO, 2007). Whereas DUCHIN, OZBAS, SENSOY (2010); BANCEL and MITTOO (2011) measure corporate investment as capital expenditure scaled by total assets of a firm. This study also used lagged capital stock as the denominator.

4) Working capital (FAZZARI and PETERSEN, 1993)

WCK (Change in Working Capital t / K t-1) $= \frac{(\text{CA}-\text{CL})\text{t}}{(\text{Capital Stock (K)})\text{t}-1}$

CA= Current Asset; CL= Current Liabilities.

This research insert Working Capital variable in the equations of regression model considering FAZZARI and PETERSEN (1993) argument that working capital input has negative relationship with fixed investment if both compete in a limited pool of finance. They also view working capital as a source of liquidity that should be used to smooth fixed investment related to cash-flow stocks if firms face finance constraints.

The definition of working capital (WC) is a little bit controversial in prior literature. Generally accepted definition is current asset (CA) minus current Liabilities (CL). DUCHIN, OZBAS and SENSOY (2010) introduce that net working capital (NWC) excluding cash ((current assets – current liabilities – cash[37]) / total assets). Thus, FAZZARI and PETERSEN

[36] Plant, property and equipment

[37] CASH = Cash, cash equivalent and short-term securities.

(1993) refer DEWING (1941)'s explanation why working capital is one of the key elements of the firm, in addition, cash and cash equivalents affect costs through the liquidity of the firm because adequate cash stocks allow firms to take advantage of discounts for prompt payment with high rate of return. Hence, *cash* cannot be excluded from the components which compose CA for the calculation of this variable in this study because the liquidity (*cash*) relates to investment. Denominator of this variable is also lagged capital stock (K *t-1*).

5) Size

$$\text{Size } t = \text{Log}\left(\frac{\text{Total Assets } t + \text{Net sales } t}{2}\right)$$

CAMPELLO, GRAHAM, HARVEY (2010) split the companies into small and large categories according to sales revenue. Total gross sales amounting to less than $1 billion are categorized as "small" and those with sales in excess of $1 billion are "large". CAMPELLO, GRAHAM, HARVEY (2010) use the number of employees (in lieu of sales) as a proxy for size. For example, experiments involving size yield the same inferences if they are classified as "small" those companies with less than 500 employees and as "large" those with more than 5000 employees.

This study defines *size* as the proxy for both the resources available inside the firm and its access to external capital markets (GOPALAN, NANDA and SERU, 2011). CARPENTER and PETERSEN (2002) argue that the increase in firm size could be difficult to be achieved if the firm has only external finance of debt, because earnings retention does not require collateral or increase the probability of financial distress.

According to ALMEIDA, CAMPELLO, LARANJEIRA and WEISBENNER (2009), since small firms are also more likely be financially constrained, it may not be surprising to find that firms that borrow on the short end are likely to suffer the most in the event of a credit contraction. GRAHAM (2000) argues that large firms often face lower informational costs when they borrow. Large firms may also have low *ex-ante* costs of financial distress. GRAHAM (2000) measures firm size with both the market value of the firm and the natural log of real sales.

Hence, it is hard to choose only one *proxy* to measure the size of a firm, this study defines the log of sum of sales revenue and total asset divided by two to control size in the equation. The summary of the variables are on table 6.

Table 6 Summary of variables for the empirical test of this study

Variable	Classification	Formula/description	Justification	Authors
Q	Explanatory variable	Q t= $\frac{\text{(Total asset - shareholders' equity + Market value of shares)}}{\text{Total asset t}}$	Measure of growth opportunity	KAPLAN and ZINGALES (1997); DUCHIN, OZBAS and SENSOY (2010)
CFK	Explanatory variable	CFK t = $\frac{\text{(EBITDA)t}}{\text{(Capital stock(K))t}-1}$	Cash flow represents the internal funds generated and available for investment	DUCHIN, OZBAS and SENSOY (2010); ZANI (2005)
WCK	Explanatory variable	WCK t= $\frac{\text{(CA}-\text{CL)t}}{\text{(Capital Stock (K))t}-1}$	Within limited pool of finance, working capital competes with investment	FAZZARI and PETERSEN (1993)
IK	Dependent variable	IK t = $\frac{\text{(Acquisition of PPE)}t}{(Capital\ stock\ \text{(K)})t-1}$ PPE = acquisition of Plant, Property and Equipment during the observation period	To relate corporate investment and explanatory variables under financing constraint status	FAZZARI, HUBBARD and PETERSEN (1988); HUBBARD (1998); WALTER (1963)
Size	Explanatory (control) variable	Size t = Log ($\frac{\text{Total Asset } t + \text{Net sales } t}{2}$)	Firm size affects external debt capacity with information asymmetry under financial constraint and negative external shock	CAMPELLO, GRAHAM, HARVEY (2010); CARPENTER and PETERSEN (2002); ZANI (2005)
CRISIS	Dummy variable	crisis = 1, post-crisis = 0	See figure 5	For the tests to compare the average of variables between crisis and post-crisis.
$\varepsilon_{it,}$	Residual regression error			

CA= Current Asset; CL = Current liabilities; EBITDA = Earnings before interest, tax, Depreciation and Amortization; PPE = plant, property and equipment; Capital stock = value of common shares and preferred shares which are recorded in shareholders' equity section of the balance sheet.

Source: author

3.3 Empirical strategy to test hypotheses

To test the hypotheses on chapter 3.1, it is necessary to find the appropriate method for each hypothesis. Following sections demonstrate the strategy how to choose the method.

3.3.1 Effect of crisis comparing with post-crisis regarding investment, growth opportunities and cash generation *(H1)*

Firms cut investment during crisis, thus unconstrained firms suffer less (ARSLAN et al. 2010). According to ARSLAN, FLORACKIS and OZKAN (2010)'s descriptive statics table (p. 34) from 1994 to 2009, mean of investment divided by total assets during pre-crisis period in Asian sample firms is 8.1%, however, throughout crisis (1997-98) and post-crisis (1999-2006), it remained as 4.1% and during Sub-prime Credit crisis period, the mean of investment to total asset recovered to 4.8%. It reveals that the investment to total asset of East Asian firms which dropped during Asian Crisis have not recovered even after ten years.

ARSLAN, FLORACKIS AND OZKAN (2010) find that financially flexible firms (high cash and low leverage) invest more than less flexible firms (low cash and high leverage) during the crisis of 1997-1998. For firms that suffer financing constraint, the demand for investment is influenced by the generation of internal funds, making it difficult to realize their attractive opportunities and promote greater risks of underinvestment, whereas for unconstrained firms, investments are conditioned by the its attractiveness (FAZZARI, HUBBARD and PETERSEN (1988) and the problems of underinvestment intensified (CAMPELLO, GRAHAM, HARVEY, 2010; DUCHIN, OZBAS and SENSOY, 2010; HUBBARD, 1988) when their information asymmetry is severe.

FAZZARI and PETERSEN (1993) contend that inventory shifts may be explained as the endogenous outcome of fixed-investment smoothing when firms face financial constraints, rather than exogenous "shock". This argument may imply that financing constraint affects more than crisis for the decision makers of financially constrained firms who should choose the level of corporate investment inside firms. Growth opportunities are proxied by the market-to-book ratio in a firm's investment opportunity set (BILLETT, KING and MAUER, 2007; LANG, OFEK and STULZ, 1996).

According to ARSLAN, FLORACKIS and OZKAN (2010), for the Low leverage and High Cash holding (LL-HC) firms in Asia, Cash flow was dropped from 12.3% (p-value<0.01) to 8.7% (p-value<0.01) between pre-crisis period (1994-1996) and Asian Crisis period (1997-98). Thus, for high leverage and low cash (HL-LC) firms with same comparison periods, their cash flow to total assets was dropped from 8.1% (p-value<0.01) to 5.1% (p-value<0.01). Both type of firms with cash and leverage measure confirmed the drop of cash flow during crisis comparing with pre-crises.

To compare the difference of investments, growth opportunities and cash generations between crisis and post-crisis the hypothesis test (*H1a and H1b*), unpaired t-test of mean (MOTULSKY and CHRISTOPOULOS, 2004; De WINTER, 2013) were done with the comparisons of proxies of IK, Q, CFK to check whether the differences of means of variables between two periods are statistically significant for financially constrained firms or financially unconstrained firms respectively. Crisis period and post-crisis period to be compared are as below.

Where,
Crisis (dummy) = 1 = crisis; years of 1998-1999; 2009; 2014-2016.
Post-crisis (dummy) = 0 = post-crisis; years of 2000-2008; 2010-2013; 2017.

3.3.2 Investment to cash-flow sensitivity and working capital relationship to investment during crisis comparing with post-crisis (*H2*)

CLEARY (1999); HUBBARD (1998); KAPLAN and ZINGALES, 1997 contend that firm investment decision are directly related to financial factors and high creditworthiness (least constrained) firms are very sensitive to the availability of internal funds. CALOMIRIS and HUBBARD (1993) find that firms that placed high shadow value on internal funds also displayed greater sensitivity of investment to internal funds. They argue that the characteristics of firms with high shadow values for internal funds and high cash flow sensitivity of investment are consistent with the asymmetric information framework. For the firms with high costs of external funds (due to asymmetric information between insiders and outsiders), investment will exhibit excessive sensitivity to cash flow, holding Q constant.

Regarding cash flow sensitivity of investment throughout crisis, ARSLAN, FLORACKIS and OZKAN (2010) expected that less flexible firms are more dependent on the level of cash flows for funding investment because of their limited ability to raise external finance. Their study results also corroborate that the financially flexible firms prior to the crisis rely much less on the availability of internal funds to invest.

Investment to cash flow sensitivity was already mentioned in the debates between FAZZARI, HUBBARD and PETERSEN (1988; 2000) and KAPLAN and ZINGALES (1997; 2000), however, investment to cash flow sensitivity difference between crisis and post-crisis by firms' financing constraint is not known for manager and investors. In addition, competition

between investment and working capital within the limited pool of finance (FAZZARI and PETERSEN, 1993) would affect financially constrained firms more in crisis than post-crisis, financially unconstrained firms may not. Therefore, H2 compares cash flow sensitivities to investment and negative relation of working capital to investment between crises and post-crises by firm's financing constraint as below to investigate whether there are differences of these relations between crises and post-crises.

To test *H2a, H2b*, *H2b and H2d, the equations for the regression is as below.*

$$\frac{I\,i,t}{K\,i,t-1} = \beta_0 + \beta_1 \frac{CF\,i,t}{K,i,t-1}, + \beta_2 \mathrm{Q}_{\,i,t} + \beta_3 \frac{\Delta WC\,i,t}{Ki,t-1}, + \beta_4 \mathrm{Size}_{\,i,t} + \varepsilon \mathrm{it} \quad . \qquad (5)$$

Where,

Crisis (dummy) = 1, years of 1998-1999; 2009; 2014-2016;

Post-Crisis (dummy) = 0, years of 2000-2008; 2010-2013; 2017.

3.4 T-test and panel data

For the tests of hypothesis (*H1*), the unpaired t-test to compare the means of the variables, and also the regression of dynamic panel data (*H2*) through the econometric software STATA/IC *version* 14.2 were used to compare the relations between crises and post-crises. The Panel Data technique draws a combination of cross-section and time series observations (BALTAGI, 2013; GUJARATI, 2009).

For the test of *H1*, this research adopted unpaired t-test to compare the means of investments, growth opportunities and cash generation between crisis and post-crisis. MOTULSKY and CHRISTOPOULOS (2004) explained that the easiest way to analyze the data between control and treatment group is to use an unpaired t-test. The data should be obtained at one time, with no pairing or matching between particular control and treated group. According to them, when p-value is above the threshold of 0.05, the difference is said not to be statistically significant. The problem with t-test is that it analyzes only the best-fit value of the parameter of interest.

For the test of *H2*, before comparing the investment to cash flow sensitivity and working capital relationship to investment between crisis and post-crisis, it is necessary to relate the variables unlike the methodology of *H1*. Therefore, the technique of regression with

panel data is adopted for financially constrained firms and unconstrained firm. This technique has been used by FAZZARI, HUBBARD and PETERSEN (1988); KAPLAN and ZINGALES (1997); CLEARY (1999); CORREA et al. (2007) and other authors. The merit of panel data of independent clusters of cross-sections over time is easily justified by the possibility of increasing the sample size by grouping data from a population in different time periods (BALTAGI, 2013).

GREENE (2012) argues that two leading cases should be considered in detail about heteroskedasticity and autocorrelation. Heteroskedasticity arises in volatile high-frequency time-series data such as daily observations in financial markets and in cross-section data where the scale of the dependent variable and the explanatory power of the model tend to vary across observations. Autocorrelation is usually found in time-series data. Economic time series often display a "memory" in the variation around the regression function is not independent from one period to the next. The author exemplifies for it as the seasonally adjusted price and quantity series published by government agencies.

According to BALTAGI (2013), the error components in the panel data regression model assume that the regression disturbances are homoskedastic, with the same variance between time and individuals, as well as assuming that the only correlation between the components of the regression error over time is due to the presence of the same individual in the panel. Therefore, it is necessary to identify, recognize and treat the biases associated with these problems that may be present in this data technique.

BALTAGI (2013, p. 63) refers "panel data" to the pooling of observations on a cross-section of households, countries, firms, etc. over several time periods which rarely exceeds ten or twenty years. He asserted that many economic applications, with a large number of observations on individuals, firms, economic sectors, regions, industries or countries but available only over a few time periods, and where time-series and cross-section data may be pooled.

According to BRUNOZI (2016) the following assumptions for panel data were considered (GUJARATI and PORTER, 2010) for his thesis, and this thesis also analyzes the below assumptions for panel data.

1) The relationships between dependent and independent variables are linear;

2) There is no perfect correlation between the explanatory variables, and, no existence of multicollinearity (correlation tests and Variance Inflation Factor (VIF) should be performed);

3) The variance of the residual is constant, that is, residuals are homoskedastic.

4) Residuals are not auto-correlated, that is, the covariance between them is zero.

5) The sum of the residuals is equal to zero and these values have normal distribution.

In addition, the variables have normal distribution and are properly measured, there is a suitable proportion between the analyzed unit numbers and the estimated parameters, and there are no endogeneity between variables.

Normally, the application of panel data with OLS (ordinary least squares) is considered as the general method of estimation. However, according to ARELLANO and BOND (1991), BLUNDELL and BOND (1998), dynamic panel data with GMM (generalized method of moments) estimator is an alternative of estimation when there are a problem of autocorrelation and heteroskedasticity and endogeneity to be solved. Therefore, if the equation models demonstrate the existence of these three aforementioned problems (especially for endogeneity problem which FAZZARI, HUBBARD and PETERSEN (1988)'s discussion participants predicted) with appropriate tests, GMM estimators should be utilized with the insertion of instrumental variables.

Nevertheless the minor differences, this thesis uses the type of sample for the present investigation is *unbalanced*, since the objective is to capture the great possible number of information. Because the *unbalanced* sample does not require the same number of firms for each group and same number of data for each firm to be empirically tested.

According to ZANI (2005), another justification to choose *unbalanced* sample is that some information has to be eliminated not to cause the problem of bias (*outliers*), as well as to obtain more information about firms because the ECONOMATICA® database has data gaps (blank data). The firms that were entered or exited the stock market during the observation period of this research may be the part of the sample. Long term observation period of twenty years can also be a justification for *unbalanced* sample.

3.5 Expecting signs

Table 7 Expecting signs

H1

Hypot-hesis	Financing constraint	Variable	Mean of variable	Difference of mean of variable between crisis and post-crisis
H1a	FCON	IK, Q, CFK	C ≠ PC	significant
H1b	FUNC	IK, Q, CFK	C =PC	not significant

H2

Hypot-hesis	Financing constraint	Dependent Variable	Explanatory variable	Coefficient	Difference of coefficients between crisis and post-crisis
H2a	FCON	IK	CFK	C ≠ PC	More sensitive during crisis
H2b	FUNC			C =PC	not significant
H2c	FCON	IK	WCK	C ≠ PC	More negative during crisis
H2d	FUNC			C =PC	not significant

C = Crisis; PC= Post-crisis; CFK = (Cash Flow t/K (capital stock) t-1); IK = (INVESTMENT t / K t-1); *WCK = ((CA-CL) t/ K t-1); FUNC*= Group of firms which are financially unconstrained; FCON = Group of firms which are financially constrained

Source: author

4 Analysis of Results

In this chapter, the main results of this thesis are presented, including the descriptive statistics of the proxies used in the models, the tests and treatments used for unpaired t-test and panel data and the results of the regressions, the tests of the proposed hypotheses and the summary of the main evidences.

4.1 Descriptive statistics

The descriptive statistics presented in table 8 summarizes the information of the variables of investment, cash flow, Q (proxy of growth opportunity), the variation of working capital and size for total sample and three different criteria with firms' financing constraint status. The information includes the mean, standard deviation, minimum value and maximum value of each variables for the period from 1998 to 2017.

The means of investment divided by capital stock (IK) demonstrate that FUNC are 133% (payout/size), 11% (cash / leverage) and 116% (size / age) higher than those of FCON. The means of cash flow divided by capital stock (CFK) demonstrate that FUNC are 317%

(payout/size), 139% (cash / leverage) and 22% (cash / leverage) higher than those of FCON. It is notable here that there were more than three times difference of average of cash flow divided capital stock in the case of payout/size criteria. However, the means of growth opportunity (proxied by Q) demonstrate a little difference between FUNC and FCON that FUNC is 22% (payout / size), -15% (cash / leverage) and 5% (size / age) higher than those of FCON comparing with the difference of other variables. Regarding the variable Q, payout / size and

Table 8 Descriptive statistics of variables of investment (IK), cash flow (CFK), growth opportunity (Q), size and variation of working capital (WCK) of total sample and groups of firms classified in financially unconstrained (FUNC) and constrained (FCON) based on the criteria with payout and size, cash and leverage and size and age (1998-2017)

	Total sample								
Variable	Mean	Std. Dev.	Min	Max					
IK	0.4688	0.8467	0.0001	9.7502					
CFK	0.7263	3.7836	-78.5934	139.9304					
Q	1.2630	0.9095	0.0003	9.9751					
WCK	0.0375	3.0681	-114.9948	56.1194					
size	6.1497	1.0340	2.3646	10.1679					
N. of observations	5225								
Criteria	**PAYOUT / FIRM SIZE**								
Classification	*FUNC*				*FCON*				
Variable	Mean	Std. Dev.	Min	Max	Variable	Mean	Std. Dev.	Min	Max
IK	0.7410	1.0760	0.0022	8.5927	IK	0.3175	0.8007	0.0001	9.2936
CFK	1.6952	3.0927	-2.2897	34.0147	CFK	0.4062	6.5661	-78.5934	139.9304
Q	1.5473	1.1419	0.1019	8.3026	Q	1.2687	1.0961	0.0003	9.3462
WCK	0.1932	1.0837	-2.8769	6.8949	WCK	-0.2708	5.2696	-114.9948	56.1194
size	7.2777	0.9294	6.4419	10.1679	size	5.0877	0.5170	2.3646	5.7333
N. of observations	455					1354			
Criteria	**CASH / LEVERAGE**								
Classification	*FUNC*				*FCON*				
Variable	Mean	Std. Dev.	Min	Max	Variable	Mean	Std. Dev.	Min	Max
IK	0.4660	0.9227	0.0001	9.7502	IK	0.4175	0.7890	0.0002	7.2291
CFK	0.3376	3.8165	-60.0000	28.8011	CFK	0.1415	3.5766	-55.1861	9.2990
Q	1.3390	1.2122	0.0004	9.9751	Q	1.5414	1.0212	0.2020	8.1076
WCK	0.7496	5.0102	-31.3402	56.1194	WCK	-0.9736	5.3898	-71.2581	10.4558
size	6.0074	1.1761	2.6906	9.7102	size	5.8518	0.9999	3.9586	9.5641
N. of observations	488					440			
Criteria	**FIRM SIZE / FIRM AGE**								
Classification	*FUNC*				*FCON*				
Variable	Mean	Std. Dev.	Min	Max	Variable	Mean	Std. Dev.	Min	Max
IK	0.6672	0.9378	0.0014	6.6456	IK	0.3086	0.8612	0.0001	9.1240
CFK	1.2601	2.5500	-6.7779	34.0147	CFK	1.0326	9.6047	-60.0000	139.9304
Q	1.4718	0.9983	0.2094	8.3026	Q	1.3970	1.1405	0.0004	7.2287
WCK	0.1553	0.9846	-5.1349	7.9918	WCK	0.4068	5.0311	-22.2490	56.1194
size	7.3162	0.7793	6.4419	9.5960	size	5.0554	0.5633	3.1151	5.7333
N. of observations	547					469			

CFK = (Cash Flow t/K (capital stock) t-1); IK = (INVESTMENT t / K t-1); WCK = ((CA-CL) t/ K t-1); Q = ((Total asset – shareholders' equity + Market value of shares) t)/(Total asset t);size = Log ((Total Asset t + Net sales t)/2); FUNC = Group of firms which are financially unconstrained; FCON = Group of firms which are financially constrained.

Source: author

size / age have similar means between FUNC and FCON, however, for cash / leverage criteria, the mean of Q of FCON is higher than FUNC.

For the means of WCK which is calculated by current asset minus current liabilities and divided by lagged capital stock, two criteria of FCON present negative means of WCK (payout / size = -0.27; cash / leverage = -0.97), whereas size / age criteria of FCON demonstrates positive number of mean (0.40).

It reveals that, for FCON, big size and old age of firms are apt to have more current asset than current liabilities on average. While, all three criteria of WCK of FUNC have positive means. Among FUNC of WCK, the mean of cash / leverage (0.74) is higher than payout / size

Table 9 Descriptive analysis of means of investment (IK), cash flow (CFK), Q, size and variation of working capital (WCK) of total sample in annual base with the comparison of YoY inserted in the middle comparison year (1998-2017)

Year	**1998**	*YoY (%)*	**1999**	YoY (%)	**2000**	YoY (%)	**2001**	YoY (%)	**2002**	YoY (%)
IK	.399	*38%*	.552	*-24%*	.417	*15%*	.481	*-22%*	.375	*3%*
CFK	.389	*40%*	.546	*24%*	.679	*-1%*	.669	*13%*	.758	*-66%*
Q	.814	*25%*	1.016	*-5%*	.963	*5%*	1.011	*1%*	1.023	*13%*
WCK	-.060	*-132%*	.019	*590%*	.136	*-146%*	-.062	*23%*	-.076	*381%*
size	5.670	*1%*	5.731	*0%*	5.754	*1%*	5.795	*1%*	5.881	*1%*
No. of observation	223		259		254		259		253	
Year	**2003**	*YoY (%)*	**2004**	*YoY (%)*	**2005**	*YoY (%)*	**2006**	*YoY (%)*	**2007**	*YoY (%)*
IK	.385	*3%*	.396	*16%*	.461	*26%*	.583	*23%*	.719	*-4%*
CFK	.259	*267%*	.952	*-20%*	.758	*66%*	1.261	*4%*	1.311	*-51%*
Q	1.161	*11%*	1.285	*9%*	1.397	*12%*	1.562	*10%*	1.720	*-34%*
WCK	-.369	*-148%*	.177	*-160%*	-.107	*-692%*	.636	*-11%*	.568	*-125%*
size	5.962	*0%*	5.969	*0%*	5.994	*1%*	6.039	*1%*	6.108	*1%*
No. of observation	256		266		260		258		268	
Year	**2008**	*YoY (%)*	**2009**	*YoY (%)*	**2010**	*YoY (%)*	**2011**	*YoY (%)*	**2012**	*YoY (%)*
IK	.687	*-26%*	.506	*17%*	.591	*-3%*	.572	*-13%*	.499	*-20%*
CFK	.638	*14%*	.725	*27%*	.920	*0%*	.916	*-17%*	.756	*-20%*
Q	1.141	*32%*	1.511	*-4%*	1.450	*-9%*	1.315	*9%*	1.429	*-1%*
WCK	-.142	*-116%*	.022	*1357%*	.334	*-91%*	.029	*-248%*	-.043	*184%*
size	6.199	*1%*	6.277	*3%*	6.443	*0%*	6.442	*0%*	6.423	*0%*
No. of observation	276		269		250		273		278	
Year	**2013**	*YoY (%)*	**2014**	*YoY (%)*	**2015**	*YoY (%)*	**2016**	*YoY (%)*	**2017**	
IK	.397	*-6%*	.375	*3%*	.387	*-29%*	.273	*3%*	.281	
CFK	.603	*8%*	.651	*-5%*	.616	*-23%*	.476	*18%*	.561	
Q	1.421	*-16%*	1.191	*-7%*	1.111	*10%*	1.226	*14%*	1.403	
WCK	-.123	*-168%*	.084	*-261%*	-.136	*22%*	-.166	*-120%*	.033	
size	6.449	*0%*	6.449	*0%*	6.434	*-1%*	6.394	*1%*	6.431	
No. of observation	266		267		271		262		257	

: crisis periods : post-crisis periods

YoY = ((mean of current year – mean of previous year)/ mean of previous year), for example, YoY which is located between 1998 and 1999, current year is 1999 and previous year is 1998); CFK = (Cash Flow t/K (capital stock) t-1); IK = (INVESTMENT t / K t-1); WCK = ((CA-CL) t/ K t-1); Q = ((Total asset – shareholders' equity + Market value of shares) t)/(Total asset t);size = Log ((Total Asset t + Net sales t)/2); FUNC = Group of firms which are financially unconstrained; FCON: Group of firms which are financially constrained.

Source: author

(0.19) and size / age (0.15). This is due to high cash and low leverage is favorable to maintain positive numerator of WCK with high current assets and low current liabilities.

Table 9 transforms the descriptive statistics (table 8) to yearly means of the variable of total sample and financing criteria with FUNC and FCON classification. Grey columns are the means of variables during crisis periods, IK started from 0.4 (1998) and dropped to 0.28 (2017). This results of Brazilian firms are similar to the pattern of ARSLAN, FLORACKIS and OZBAS (2010)'s descriptive statistics for all firms from 1994 to 2009 for Asian countries. Their means of investment[38] during pre-crisis period 1994-1996 (0.081) dropped during Asian Crisis Period 1997-1998 (0.041) had not been recovered until Credit crisis period 2007-2009 (0.048). It reveals that once investment dropped with crisis, these adverse effects has been long and hard to be fully recovered for the firms.

Referring from table 9, CFK started from 0.39 in 1998, however, if falls down drastically in 2003 to 0.25, and it increased up to 0.95 (+267%) on the following year (2004). In 2007, it peaked up to 1.311 but, in 2008, it dropped to 0.63. For Q, it fluctuated from 1.0 to 1.7 from 2001 to 2017, however, the peak was 1.72 in 2007. Regarding WCK, it peaked up from 0.5 to 0.6 during 2006 and 2007, however all the rest periods have remained slightly negative or positive from zero except 2010 (0.33). The most interesting part in this annual

Table 10 VIF (Variance Inflation Factor) test results of variables investment (IK), cash flow (CFK), Q, size and variation of working capital (WCK) of total sample by groups of firms classified in financially unconstrained (FUNC) and constrained (FCON) based on the criteria with payout and size, cash and leverage and size and age (1998-2017)

Criteria		Total Sample	PAYOUT / SIZE		CASH / LEVERAGE		FIRM SIZE / FIRM AGE	
			FUNC	*FCON*	*FUNC*	*FCON*	*FUNC*	*FCON*
Dependent v.	IK							
Explanatory variable	CFK	1.14	1.22	1.15	1.21	1.05	1.13	1.69
	Q	1.00	1.14	1.15	1.13	1.07	1.02	1.15
	WCK	1.13	1.08	1.05	1.09	1.05	1.07	1.70
	size	1.01	1.04	1.04	1.01	1.07	1.06	1.16
	Mean VIF	1.07	1.12	1.10	1.11	1.06	1.07	1.43

CFK = (Cash Flow t/K (capital stock) t-1); IK = (INVESTMENT t / K t-1); WCK = ((CA-CL) t/ K t-1); Q = ((Total asset – shareholders' equity + Market value of shares) t)/(Total asset t);size = Log ((Total Asset t + Net sales t)/2); FUNC = Group of firms which are financially unconstrained; FCON = Group of firms which are financially constrained.

Source: author

[38] Their *investment* is measured as the ratio of capital expenditures to total assets (ARSLAN, FLORACKIS and OZBAS, 2010).

comparison of the variables is that all the peak of IK (0.719), CFK (1.311) and Q (1.72) hit the records in 2007. And thereafter, IK and CFK were decreased and never recovered the peaks of 2007 until 2017.

To verify multicollinearity problems among explanatory variables, on table 10, the variance inflation factor (VIF) test was done and all the estimates were less than two. According to BRUNOZI (2016), the recommended VIF is less than ten, in more robust model, VIF (s) of

Table 11 Correlation matrix of the variables investment (IK), cash flow (CFK), Q, size and variation of working capital (WCK) of total sample by groups of firms classified into financially unconstrained (FUNC) and constrained (FCON) based on the criteria with payout / size, cash / leverage and size / age (1998-2017)

Total sample					
	IK	CFK	Q	size	WCK
IK	1.0000				
CFK	0.1276***	1.0000			
Q	0.0490***	0.0112	1.0000		
size	0.0938***	0.0527***	-0,0144	1.0000	
WCK	0.0575***	0.3409***	-0.0390***	0.0193	1.0000
No. of observation	5225				

Criteria	PAYOUT / FIRM SIZE										
Classification	*FUNC*					Classification	*FCON*				
	IK	CFK	Q	size	WCK		IK	CFK	Q	size	WCK
IK	1.0000					IK	1.0000				
CFK	0.5356***	1.0000				CFK	-0.0848**	1.0000			
Q	0.0196	0.4127***	1.0000			Q	0,0067	-0.042	1.0000		
size	-0.0526	-0.0207	-0.1132**	1.0000		size	0.0109	0.0272	-0.1414***	1.0000	
WCK	0.1836***	0.3236***	0.1189**	-0.1094**	1.0000	WCK	-0.0006	0.3386***	-0.0766***	-0.0291	1.0000
No. of observation	455						1354				

Criteria	CASH / LEVERAGE										
Classification	*FUNC*					Classification	*FCON*				
	IK	CFK	Q	size	WCK		IK	CFK	Q	size	WCK
IK	1.0000					IK	1.0000				
CFK	-0.3143***	1.0000				CFK	-0.1275***	1.0000			
Q	0.0795*	-0.1192***	1.0000			Q	-0.0200	-0.0759	1.0000		
size	-0.0005	-0.0266	0.0583	1.0000		size	-0.0037	0.0902*	-0.2978***	1.0000	
WCK	0.3546***	0.2243***	-0.0702***	-0.11479**	1.0000	WCK	-0.4425***	0.6379***	-0.1073**	0.1202***	1.0000
No. of observation	488						440				

Criteria	FIRM SIZE / FIRM AGE										
Classification	*FUNC*					Classification	*FCON*				
	IK	CFK	Q	size	WCK		IK	CFK	Q	size	WCK
IK	1.0000					IK	1.0000				
CFK	-0.0298	1.0000				CFK	-0.0298	1.0000			
Q	-0.0225	-0.0058	1.0000			Q	-0.0225	-0.0058	1.0000		
size	0.047	0.0192	-0.2097***	1.0000		size	0.0470	0.0192	-02097***	1.0000	
WCK	0.2690***	0.0702	0.0361	-0.0485	1.0000	WCK	0.2690***	0.0702	-0.0361	-0.0485	1.0000
No. of observation	547						469				

***: ** and * indicate statistical significance with the level of 1%, 5% and 10%, respectively.

CFK = (Cash Flow t/K (capital stock) t-1); IK = (INVESTMENT t / K t-1); WCK = ((CA-CL) t/ K t-1); Q = ((Total asset – shareholders' equity + Market value of shares) t)/(Total asset t);size = Log ((Total Asset t + Net sales t)/2); FUNC = Group of firms which are financially unconstrained; FCON: Group of firms which are financially constrained.

Source: author

less than five indicates good modeling quality. The result of this test did not detect any problems of VIF.

Table 11 demonstrates the correlation matrix between the variables. The correlation matrix presented in table 11 enables to observe whether there were correlation between variables which are utilized to test hypotheses. The correlation tests are performed by for FUNC and FCON which are consist of the three different financing constraint criteria (payout / size, cash / leverage, size / age).

According to RUMSEY (2016), for the correlation test with variables, when they have the linearity, the variables which correlates more than 0.7 the author defines as "a strong relation", more than 0.5 and less than 0.7 as "a moderate relationship". Most of the criteria of FUNC and FCON corroborate the correlations is below the range of *moderate* correlation (below 0.5), however, in the criteria of payout / size of FUNC, the variables of IK and CFK demonstrate the moderate relationship of correlation (0.5356), also for FCON with cash / leverage criteria, the correlation between WCK and CFK is observed as 0.6379 with 1% significance level ($p<0.01$).

4.2 Test of Hypotheses with t-test and Panel data

The test of hypotheses were done with two different statistical methodologies considering the appropriate responses for each hypothesis (*H1/H2*) to compare the investment related variables and cash flow sensitivity and working capital relation to investment between crisis and post-crisis period. For *H1*, *unpaired t-test* were selected to compare whether there are some differences regarding the variables of investment, Q and cash flow between crises and post-crises periods. For *H2*, to compare the investment to cash flow sensitivity and working capital relations to investment between crisis and post-crisis, firstly, GMM estimators were utilized to estimate the relationships between variables. Secondly, these results (coefficients) are compared between crises and post-crises only when the coefficients of bother periods are statistically significant to check if there are significant differences of the sensitivities or relations between variables. Finally, to supplement the deficiencies from manually obtained comparison differences of coefficients for *H2* obtained by dynamic panel data (GMM),

bivariate regressions were supplemented to obtain the statistical significance of the differences from the system.[39]

4.2.1 Test of *H1 (Hypothesis 1*) with t-test

For the unpaired t-test, the null hypothesis that the population means related to two independent, random samples from normal distribution are equal (ALTMAN, 1990; ARMITAGE and BERRY, 1994). The unpaired t-test should not be used if there is a significant

Table 12 Unpaired t-test result to investigate whether there are differences of investment between crisis and post-crisis for the financial unconstrained firms and constrained firms with three different criteria

TOTAL SAMPLE						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
IKC	1,551	0.4159	0.0193	0.7609	0.3780	0.4538
IKP	3,674	0.4911	0.0145	0.8795	0.4627	0.5196
combined	5,225	0.4688	0.0117	0.8467	0.4458	0.4917
diff		-0.0753	0.0256		-0.1255	-0.0250
t = -2.9373		degrees of freedom = 5223			Pr(|T| > |t|) = 0.0033	

PAYOUT / SIZE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
IKC	141	0.6261	0.0771	0.9154	0.4737	0.7785	IKC	406	0.2990	0.0320	0.6448	0.2361	0.3619
IKP	314	0.7926	0.0642	1.1384	0.6662	0.9190	IKP	948	0.3255	0.0279	0.8590	0.2707	0.3802
combined	455	0.7410	0.0504	1.0760	0.6419	0.8402	combined	1,354	0.3175	0.0218	0.8007	0.2749	0.3602
diff		-0.1665	0.1089		-0.3806	0.0475	diff		-0.0265	0.0475		-0.1196	0.0667
t = -1.5288		degrees of freedom = 453			Pr(|T| > |t|) = 0.1270		t = -0.5569		degrees of freedom = 1352			Pr(|T| > |t|) = 0.5777	

CASH / LEVERAGE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
IKC	113	0.4883	0.0945	1.0047	0.3010	0.6755	IKC	142	0.3454	0.0622	0.7413	0.2224	0.4684
IKP	375	0.4593	0.0464	0.8979	0.3681	0.5505	IKP	298	0.4518	0.0469	0.8097	0.3595	0.5441
combined	488	0.4660	0.0418	0.9227	0.3839	0.5481	combined	440	0.4175	0.0376	0.7890	0.3435	0.4914
diff		0.0290	0.0991		-0.1658	0.2237	diff		-0.1064	0.0804		-0.2644	0.0516
t = 0.2924		degrees of freedom = 486			Pr(|T| > |t|) = 0.7701		t = 1.3236		degrees of freedom = 438			Pr(|T| > |t|) = 0.1863	

FIRM SIZE / FIRM AGE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf.	Interval]
IKC	167	0.6459	0.0773	0.9991	0.4969	0.8022	IKC	148	0.2461	0.0442	0.5378	0.1587	0.3334
IKP	380	0.6749	0.0467	0.9108	0.5831	0.7668	IKP	321	0.3374	0.0544	0.9742	0.2304	0.4444
combined	547	0.6672	0.0401	0.9378	0.5884	0.7459	combined	469	0.3086	0.0398	0.8612	0.2304	0.3867
diff		-0.0254	0.08714		-0.1966	0.1458	diff		-0.0913	0.0856		-0.2594	0.0768
t = -0.2915		degrees of freedom = 545			Pr(|T| > |t|) = 0.6146		t = -1.0674		degrees of freedom = 467			Pr(|T| > |t|) = 0.2864	

diff = mean (IKC) – mean (IKP); Ho: diff = 0; Ha: diff ≠ 0; IKC = investment/K during crisis; IKP = investment / K during post-crisis

Source: author

[39] STATA/IC *version* 14.2 doesn't provide the statistical significance of comparison differences to IV (instrumental variables) regression such as GMM or 2SLS. However, static regression can use *[SUEST A B]* option which compares the coefficients between different groups or periods and it demonstrates the statistical significance of differences of coefficients between them. This is why the tests for *H2* were firstly manually compared the differences of coefficients with GMM estimators and finally supplemented by bivariate regression to obtain the statistical significance from STATA.

difference between the variances of the two samples (ARMITAGE and BERRY, 1994).

Table 12 demonstrates the mean differences between the two variables of investment during crisis (IKC) and investment during post-crisis (IKP) which are proxies of investment between crisis and post-crisis. For total sample, mean of IKC is 0.415, and mean of IKP is 0.491 and difference between them are -0.07. The statistical significance (two tailed p-value) of the unpaired t-test (Pr(|T| > |t|)) under Ha: mean (diff) = 0), which is 0.0033. As the p-value is less than 0.05 (i.e., $p < 0.05$), that means the difference is significant.

However, for each criteria of FUNC and FCON, no criteria demonstrated the significant difference of IK between crisis and post-crisis ($p< 0.05$). Those confirm that there are no significant differences of investment between crises and post-crises for both financially constraint firms (*H1a*) and financially unconstrained (FUNC) firms (*H1b*).

Table 13 demonstrates the mean differences between the two variables (QC (Q during Crises) and QP (Q during Post-crises)) which are proxies of growth opportunity between crisis and post-crisis. For total sample, mean of QC is 1.155, and mean of QP is 1.308 and difference between them are -0.152 with the statistical significance ($p<0.01$).

However, there are the significant differences of growth opportunity (Q) between crisis and post- crisis for three criteria of FUNC or FCON: 1) FCON (payout/ size) = Mean of QC is 1.113, QP is 1.335, and the difference is -0.22 ($p<0.01$); 2) FUNC (Cash / leverage) = Mean of QC is 0.9457, QP is 1.457, and the difference is -0.51 ($p<0.01$); 3) FUNC (Size / Age) = Mean of QC is 1.3449, QP is 1.5276, and the difference is -0.18 ($p<0.05$). Unlike other two variables (IK and CFK), only Q demonstrate significant differences between crises and post-crises for three out of six total financing criteria (one in FCON; two in FUNC). It may be due to the fact that market value in the numerator of Q is generally affected during recession periods.

Table 13 Unpaired t test result to investigate whether there are differences of growth opportunity (Q) between crisis and post-crisis for the financial unconstrained firms and constrained firms with three different criteria

TOTAL SAMPLE

Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]
QC	1,551	1.1557	0.0199	0.7850	1.1166	1.1948
QP	3,674	1.3084	0.0157	0.9537	1.2775	1.3392
combined	5,225	1.2630	0.0126	0.9095	1.2384	1.2877
diff		-0.1527	0.02746		-0.2065	-0.098833
t = -5.5593		degrees of freedom = 5223			Pr(|T| > |t|) = 0.0000	

PAYOUT / SIZE

FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]
QC	141	1.3994	0.0960	1.1398	1.2096	1.5891	QC	406	1.1133	0.0435	0.8759	1.0278	1.1988
QP	314	1.6138	0.0642	1.1384	1.4874	1.7402	QP	948	1.3353	0.0381	1.1719	1.2606	1.4100
combined	455	1.5473	0.0535	1.1419	1.4421	1.6525	combined	1,354	1.2687	0.0298	1.0961	1.2103	1.3272
diff		-0.2144	0.1154		-0.4413	0.0124	diff		-0.2220	0.0648		-0.3490	-0.0950
t = -1.8575		degrees of freedom = 453			Pr(|T| > |t|) = 0.0639		t = -3.4288		degrees of freedom = 1352			Pr(|T| > |t|) = **0.0006**	

CASH / LEVERAGE

FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]
QC	113	0.9457	0.0725	0.7708	0.8021	1.0894	QC	142	1.4838	0.0746	0.8886	1.3364	1.6312
QP	375	1.4575	0.0668	1.2941	1.3261	1.5890	QP	298	1.5688	0.0625	1.0791	1.4458	1.6919
combined	488	1.3390	0.0549	1.2122	1.2312	1.4469	combined	440	1.5414	0.0487	1.0212	1.4457	1.6371
diff		-0.5118	0.1281		-0.7636	-0.2600	diff		-0.0851	0.1042		-0.2898	0.1197
t = -3.9943		degrees of freedom = 486			Pr(|T| > |t|) = **0.0001**		t = -0.8166		degrees of freedom = 438			Pr(|T| > |t|) = 0.4146	

FIRM SIZE / FIRM AGE

FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	[95% Conf	Interval]
QC	167	1.3449	0.0733	0.9478	1.2001	1.4897	QC	148	1.3031	0.0858	1.0442	1.1334	1.4727
QP	380	1.5276	0.0521	1.0159	1.4251	1.6301	QP	321	1.4403	0.0659	1.1814	1.3106	1.5700
combined	547	1.4718	0.0427	0.9983	1.3880	1.5556	combined	469	1.3970	0.0527	1.1405	1.2935	1.5005
diff		-0.1827	0.0924		-0.3643	-0.0011	diff		-0.1372	0.1133		-0.3598	0.0853
t = -1.9767		degrees of freedom = 545			Pr(|T| > |t|) = **0.0486**		t = -1.2117		degrees of freedom = 467			Pr(|T| > |t|) = 0.2262	

diff = mean(QC) - mean(QP); Ho: diff = 0; Ha: diff ≠ 0; QC = Q during crisis; QP= Q during post-crisis

Source: author

Table 14 demonstrated the mean difference between the two variables (CFKC (CFK during Crisis) and CFKP (CFK during post-crisis)) which are proxies of cash generation of firms between crisis and post-crisis. For total sample, mean of CFKC is 0.5737, mean of CFKP is 0.7907 and the difference between them are -0.2170, however the difference between two variables (cash generation between crisis and post-crisis) is not significant (0.0582) with p-value <0.05. In addition, for each criteria of FUNC and FCON, no criteria demonstrated the significant difference under the t-test.

Table 14 Unpaired t-test result to investigate whether there are differences of cash generation (cash flow/ K) between crisis and post-crisis for the financial unconstrained firms and constrained firms with three different criteria.

TOTAL SAMPLE						
Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]
CFKC	1,551	0.5737	0.0471	1.8559	0.4812	0.6661
CFKP	3,674	0.7907	0.0717	4.3466	0.6501	0.9313
combined	5,225	0.7263	0.0523	3.7836	0.6237	0.8289
diff		-0.2170	0.1145		-0.4415	0.0076
t = -1.8945		degrees of freedom =		5223	Pr(|T| > |t|) = 0.0582	

PAYOUT / SIZE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]
CFKC	141	1.4494	0.2760	3.2770	0.9038	1.9950	CFKC	406	0.2796	0.0825	1.6628	0.1174	0.4418
CFKP	314	1.8055	0.1696	3.0052	1.4718	2.1392	CFKP	948	0.4604	0.2524	7.7721	-0.0350	0.9557
combined	455	1.6952	0.1450	3.0927	1.4102	1.9801	combined	1,354	0.4062	0.1784	6.5661	0.0561	0.7562
diff		-0.3561	0.3134		-0.9720	0.2598635	diff		-0.1808	0.3896		-0.9450	0.5834
t = -1.1361		degrees of freedom =		453	Pr(|T| > |t|) = 0.2565		t = -0.4640		degrees of freedom =		1352	Pr(|T| > |t|) = 0.6427	

CASH / LEVERAGE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]
CFKC	113	0.1715	0.1509	1.6042	-0.1275	0.4705	CFKC	142	0.1054	0.2835	3.3777	-0.4550	0.6657
CFKP	375	0.3876	0.2202	4.2643	-0.0454	0.8206	CFKP	298	0.1587	0.2128	3.6730	-0.2600	0.5774
combined	488	0.3376	0.1728	3.8165	-0.0019	0.6770	combined	440	0.1415	0.1705	3.5766	-0.1936	0.4766
diff		-0.2160	0.4099		-1.0214	0.5893	diff		-0.0533	0.3651		-0.7709	0.6642
t = -0.5271		degrees of freedom =		486	Pr(|T| > |t|) = 0.5984		t = -0.1461		degrees of freedom =		438	Pr(|T| > |t|) = 0.8839	

FIRM SIZE / FIRM AGE													
FUNC							FCON						
Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]	Variable	Obs	Mean	Std. Err.	Std. Dev.	95% Conf	Interval]
CFKC	167	1.0817	0.1967	2.5425	0.6933	1.4701	CFKC	148	0.1535	0.1204	1.4651	-0.0845	0.3915
CFKP	380	1.3384	0.1310	2.5528	1.0810	1.5959	CFKP	321	1.4379	0.6447	11.5503	0.1696	2.7062
combined	547	1.2601	0.1090	2.5500	1.0459	1.4742	combined	469	1.0326	0.4435	9.6047	0.1611	1.9041
diff		-0.2568	0.2367		-0.7217	0.2082	diff		-1.2844	0.9535		-3.1581	0.5892
t = -1.0847		degrees of freedom =		545	Pr(|T| > |t|) = 0.2785		t = -1.3471		degrees of freedom =		467	Pr(|T| > |t|) = 0.1786	

diff = mean(CFKC) - mean(CFKP); Ho: diff = 0; Ha: diff ≠ 0; CFKC = cash flow/K during crisis; CFKP = cash flow / K during post-crisis

Source: author

Summarizing t-test result of investment, growth opportunity (Q) and cash generation between crisis and post-crisis with the proxies of IKC/IKP, QC/QP and CFKC/CFKP, total three criteria (FCON (payout / size); FUNC (cash / leverage); FUNC (size / age)) of Q demonstrated the significant differences of reductions between crises and post-crises. Comparing with the expecting sign, only one criteria of FCON (payout/ size) of variable Q (growth opportunity) is consistent with the hypothesis 1 (*H1a*). Whereas, for financially unconstrained firms, criteria of cash / leverage and size / age of Q demonstrated significant differences of growth opportunities between crises and post-crises (proxied by QC and QP) with $p<0.05$. Payout / size of IKC/IKP and all the criteria of QC/QP and CFKC/CFKP of FUNC

are aligned with *H1b* which financially unconstrained firms (FUNC) don't demonstrate more reduction of investment, growth opportunity and cash generation during crises comparing with post-crises.

4.2.2 Test of *H2* (Hypothesis 2) with dynamic panel data and comparison of the coefficients

BALTAGI (2013, p. 6) refers HSIAO (2007)'s several benefits of using panel data. The use of panel data enables to control for the individual heterogeneity. Panel data suggest that individuals, firms, states or countries are heterogeneous.

The panel data represent a model of estimation of more dynamic and heterogeneous possibilities in the relationships between the variables (WOOLDRIDGE, 2010) which enriches the empirical analysis. The panel data applied for this thesis is *unbalanced* [40], since variations occurred from the observations in the analyzed periods. In addition, firstly, a static panel data technique with the Ordinary Least Squares (OLS) method was assumed to test the hypotheses until the detections of heteroskedasticity or autocorrelation or endogeneity which three problem are suggested to be solved with the dynamic panel data such as GMM estimators with the insertion of instrumental variables that is known to mitigate the endogeneity problem.

4.2.2.1 Test of panel data with fixed effect, random effect

According to BALTAGI (2013), choosing Fixed Effect (FE) or Random Effect (RE) issues debate in the biometrics and statistics literature (BALTAGI, 2013, p. 24), however, the specification test proposed by HAUSMAN which is based on the difference between the fixed and random effect. HAUSMAN (1978) proposed a test based on the difference between the random effects and fixed effects estimates. Since FE is consistent when c_i and x_{it} are correlated, but RE is inconsistent, a statistically significant difference is interpreted as the evidence against the random effects assumption is estimators are done to verify to use for this study. One of the caveats which WOOLDRIDGE (2010, p. 289) mentioned is strict exogeneity, correlation between x_{is} and u_{it} for any s and t causes both FE (fixed effect) and RE (random effect) to be inconsistent if an explanatory variable in some time period is correlated with u_{it} (WOOLDRIDGE, 2010, p. 299).

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[40] See 3.4.2

Table 15 summarizes the test information and the results suggest the use of the fixed effects model and random effects (BALTAGI, 2013) based on prob>chi2 is below 0.05 (fixed effect) or not (random effect). To decide between fixed or random effects, it should run a HAUSMAN test where the null hypothesis is that the preferred model is random effects with the alternative of the fixed effects (GREENE, 2012). It basically tests whether the unique errors (*ui*) are correlated with the regressors, the null hypothesis is they are not. Table 15 demonstrates HAUSMAN test result of total sample in STATA/IC *version*14.2, and the result suggests the use of the fixed effects model.

4.2.2.2 Tests for Problems of heteroskedasticity and autocorrelation

According to BALTAGI (2013), the assumption of presence of homoskedasticity and absence of autocorrelation for the standard error component model is very restrictive for panel data. The presence of heteroskedasticity occurs when the variance of the errors is not constant, violating the assumption to be homoskedasticity (BALTAGI, 2013; GUJARATI, 2009).

Table 15 HAUSMAN test result to decide the application of FE (Fixed) effects or RE (Random) effects for total sample (1998-2017)

Total sample				
Dependent variable	I/K			
Explantory vari	(b) FE	(B) RE	(b-B) diff.	sqrt(diag(V_b-V_B)) S.E
Q	0.053053	0.046252	0.006802	0.0074165
CFK	0.032974	0.016129	0.016845	0.002516
WCK	0.009583	0.014123	-0.00454	0.002155
size	-0.04565	0.019203	-0.06485	0.0300961
No. of observation		5225		
obs. periods (years)		20 year (1998-2017)		
Test: Ho: difference in coefficients not systematic				
b = consistent under Ho and Ha; obtained from xtreg				
B = inconsistent under Ha, efficient under Ho; obtained from xtreg				
chi2(4) = (b-B)'[(V_b-V_B)^(-1)](b-B)= 51.56				
Prob>chi2 = 0.0000				
Result of Hausman Test (FE X RE)		**Fixed effect**		

** When the dependent variables is IK, the command for HAUSMAN TEST in STATA/IC version 14.2 is "hausman fe re" after storing each effect of fixed effects and random effects with "estimates store fe (re)" after each panel data regression "xtreg (variables) fe (re)".. See table A-1 in appendix for more information.*
Source: author

The presence of heteroskedasticity can be explained by the reasons such as the presence of *outliers (*PORTAL, ZANI and SILVA, 2012), or the problems of specification of the theoretical model, or asymmetry in the distribution of one or more regressors. The main

consequences of heteroskedasticity are to affect the significance of the results and the possibility of presenting a biased estimator. On the other hand, the problem of autocorrelation between errors is common to time series data, being explained by inertia problems such as economic series, bias problems of specification of the models, problems of lags as a function of past error affecting future error, as well as other situations of transformation or manipulation of data (GUAJARTI, 2012).

Table A-2 in *Appendix* is to evaluate the presence of heteroskedasticity based on the first specification of the hypothesis test (*H2*) proposed by this thesis. Testing variables in the equation of this thesis which are derived from FAZZARI, HUBBARD and PETERSEN (1988) and FAZZARI and PETERSEN (1993) equation models. Thus, the heteroskedasticity test was operationalized by the "*xttest3*" command of the STATA / IC *version* 14.2, which reports the Modified WALD test for panel data for fixed effect model, as suggested by GREENE (2012). In addition, on Table A-3 in *Appendix,* BREUSCH and PAGAN test (BALTAGI, 2013) for heteroskedasticity with random effects were done with the command of "*hettest*" in STATA/IC *version* 14.2, a chi-squared test which the test statistic is distributed nχ2 with k degrees of freedom. If the test statistic has a p-value below an appropriate threshold ($p < 0.05$), then the null hypothesis of homoskedasticity is rejected and heteroskedasticity is assumed. All the test (modified Wald test and Breusch and Pagan test) results for the financing constraint criteria of this study confirmed the presence of heteroskedasticity.

For the autocorrelation test[41] (see Table A-4 in *Appendix*), both BALTAGI-WU (1999)'s LBI and BHARGAVA, ALOK, FRANZINI, and NARENDRANATHAN (1982)'s Durbin-Watson statistic (BALTAGI, 2013) rejected the null hypothesis of no first-order serial correlation, that is to say, all the financing criteria demonstrate the presence of autocorrelations.

4.2.2.3 Endogeneity and application of instrumental variable

According to GREENE (2012, p. 259), in the linear regression model of $Y_{it} = X'_i\beta + \varepsilon_i$, there are many cases which assumption that X_i and ε_i are uncorrelated is untenable. In case two set of variables, x_1 and x_2, with the assumption that x_1 is not correlated with ε, but x_2 is correlated with ε, it is assumed that x_1 is exogenous, and x_2 is endogenous in the model. The

[41] STATA / IC 14.2 command "*xtregar (variables) LBI*" was used to test autocorrelation for panel data.

author exemplified the case of some omitted right-hand-side variables bias in the least squares estimator of the mis-specified equation, dynamic effects etc.

The most important estimation process of the reduced-form investment equation models based on FAZZARI, HUBBARD and PETERSEN (1998), which this thesis applies to relate firm's investment and financing decisions in the presence of financial constraint, is to check the presence of endogeneity.

In the "General Discussion part" of FAZZARI, HUBBARD and PETERSEN (1988), the authors refer that

> "James Tobin noted that the firm jointly determines *investment*, dividend payments, and other ways of allocating its *cash flow*. Therefore, he suggested that the authors model investment and dividends as depending on the same set of explanatory variables. Their colleague (SIMS) points out that the potential pitfalls of the authors' econometric method. First, *cash flow* may be a key source of information to the firm about future profitability. Hence *investment should be correlated with cash flow* even with perfect capital markets. (…..). Even in the absence of a correlation between investment opportunities and cash flow in the entire population of firms, it is possible that the authors' method of classification will group together firms that, by chance, have cash flow roughly equal to their investment needs.

The criticism in FAZZARI, HUBBARD and PETERSEN (1988) discussion part implies that the dependent variable (Investment) and cash flow (explanatory variable) in this thesis based on FAZZARI, HUBBARD and PETERSEN (1988)'s reduced-form equation model have an inherited doubt of endogeneity problem (BRUNOZI, 2016; KAPPEL, 2017). According to PORTAL, ZANI and SILVA (2013), the theory suggests that some decisions are determined simultaneously, and the estimation by OLS (ordinary least squares) would generate inconsistency of the estimators because the error associated with the equation may be correlated with the other endogenous variables, violating the hypothesis of interdependence errors in relation to the explanatory variables. In order to avoid the problem in question, they suggested the system of equations estimated by more than two stage least squares (PORTAL, ZANI and SILVA, 2012; PORTAL, ZANI and SILVA, 2013).

However, DAVIDSON and MacKINNON (1999) questioned the usefulness of instrumental variables for the suspicious endogeneity as follows.

> In many cases, we do not know whether we actually need to use instrumental variables. For example, we may suspect that some variables are measured with error, but we may not know whether the errors are large enough to cause enough inconsistency for us to worry about. Or we may suspect that certain explanatory variables are endogenous, but we may not be at all sure of our suspicions, and we may not know how much inconsistency would result if they were justified. In such a case, it may or may not be perfectly reasonable to employ OLS estimation.

In spite of the doubt to use instrumental variable is appropriate or not, they suggested an augmented regression test (DURBIN-WU-HAUSMAN (DWH) test) to check whether the difference of estimated coefficient of IV (instrumental variable) and coefficient of OLS is significantly different from zero in the available sample (DAVIDSON and MACKINNON, 1999). According to them, it would evidently be very useful to be able to test the null hypothesis that the error terms are uncorrelated with all the regressors against the alternative that they are correlated with some of the regressors. The table A-5 in *Appendix* demonstrates the endogeneity test with STATA software in case that the suspicious variable with endogeneity is assumed as variable CFK. The small p-value indicates that OLS is not consistent. Therefore, all the results of the financing constraint criteria rejected the null hypothesis of exogeneity. That is, they are endogenous.

To solve the endogeneity problem, GREENE (2012, p. 262) suggests the insertion of Instrumental Variables (DAVIDSON and MACKINNON, 1999) with two-stage least squares (2SLS) as the generalized method of moments (GMM) estimators. According to ARELLANO and BOND (1991); BLUNDELL and BOVER (1998), GMM is an alternative estimation that can solve the problems of autocorrelation, heteroskedasticity and endogeneity of the OLS estimates, providing consistent operations for the regression (HANSEN, 1982). The IV estimator is a powerful tool that underlies a great deal of contemporary empirical researches (GREENE, 2012).

Considering the theoretical assumption that investment and financing decisions are interdependent (FAZZARI, HUBBARD and PETERSEN, 1988; KAPLAN and ZINGALES, 1997; FAZZARI, HUBBARD and PETERSEN, 2000; KAPLAN and ZINGALES, 2000;

ALMEIDA and CAMPELLO, 2010; PORTAL, ZANI and SILVA, 2012), the estimation of a multivariate linear OLS (Ordinary Least Squares) regression generates inconsistent estimators because the error of the equation is correlated with the other endogenous variables, violating the hypothesis of independence between errors with explanatory variables. It occurs due to the error of measurement of the variables (omitted variables, auto selection etc.). Hence, this research which follows FAZZARI, HUBBARD and PETERSEN (1988)'s model also doubts the endogeneity, it is necessary to consider the use of instrumental variables for model estimation by 2SLS or by GMM (GREENE, 2012).

Another theoretical argument regarding the insertion of instrumental variables other than cash flow endogeneity argument which is defined by FAZZARI, HUBBARD and PETERSEN (1988)'s participants, ALMEIDA and CAMPELLO (2007) confessed that one issue to consider whether the presence of Q in their regressions will bias the inferences that they can make about the impact of cash flows on investment spending. Such concerns have become a topic of debate in the literature, as the evidence of higher investment-cash flow sensitivities for constrained firms has been ascribed to measurement and interpretation problems with regressions including Q. This is also proposed testing strategy which sidesteps this problem because their empirical test is independent of the level of the estimated cash flow coefficients of constrained and unconstrained.

To solve the interdependence of financial decisions and, in order to avoid specification problems (GATCHEV, PULVINO and TARHAN, 2010; PORTAL, ZAN I and SILVA, 2012), the problems of endogeneity were analyzed and properly treated in this research. To solve the endogeneity problem, GMM estimators with 2SLS are utilized as the studies of PORTAL, ZANI and SILVA (2012); PORTAL, ZANI and SILVA (2013); ALMEIDA and CAMPELLO (2007); ACHARYA, ALMEIDA and CAMPELLO (2007); ALMEIDA and CAMPELLO (2010); BRUNOZI (2016).

According to FAZZARI, HUBBARD and PETERSEN (1988); ALMEIDA and CAMPELLO (2007), firstly, the cash flow variable was considered endogenous and it was instrumented (PORTAL, ZANI and SILVA, 2012) by the year t-1 and t-2 lags (BRUNOZI, 2016). That is, the GMM estimator models of this research include two previous years of CFK *t*. Secondly, for the robustness of instrumental variables, Q was also additionally instrumented with two previous lags (Q_{t-1} and Q_{t-2}) together with CFK $_{t-1}$ and $_{t-2}$. The necessity of Q as the

instrument variables would be validated with the over-identification test and endogeneity test in the following chapter.

4.2.2.4 Dynamic Panel data regression and comparison of the results between crisis and post-crisis (H2)

The preparatory tests and information were presented in chapter 4.2. During the treatment of all potential problems mentioned, also, the endogeneity test (Table A-5 in *appendix*) in STATA/IC *version* 14.2 detected the endogeneity problem as the theory suggested. In the similar vein, GREENE (2012, p. 434) mentioned that recent panel data applications have relied heavily on the methods of instrumental variables. This research considers generalized method of moment (GMM) estimation as suggested by GREENE (2012) to mitigate the endogeneity problem. According to BALTAGI (2013, p.173), BUN and KIVIET (2006) analyzed that additional regressor(s) may be correlated with the individual effects and is predetermined. They argue that the bias of the GMM estimators tends to increase with the number of moment conditions exploited.

The strategy to choose appropriate IV (instrumental variables) to substitute "instrumented" variables referred to the arguments[42]: (1) the participants in the discussion part of FAZZARI, HUBBARD and PETERSEN (1988) that *cash flow may be a key source of information to the firm about future profitability and investment should be correlated with cash flow*; (2) ALMEIDA and CAMPELLO (2007) argue that *the presence of Q in their regressions will bias the inferences that they can make about the impact of cash flows on investment spending.*

Therefore, to solve endogeneity problem of this research, it is necessary to substitute the instrumented variables CFK*t* for IV (instrumental variables) for lagged CFK*t-1* and CFK*t-2* which are to be estimated by 2SLS[43] (Two-stage least squares) inside GMM estimators (GREENE, 2012) to test each hypothesis in *H2* and to compare the differences of coefficient between crises and post-crises.

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[42] See chapter 4.2.2.3

[43] According to GREENE (2012, p. 271), Y is computing in two steps, first by computing X (set of instrument), then by the least squares regression. For this reason, this is called the two-stage least squares (2SLS)

After that, another empirical test with the addition of Q variable as the IV were done[44] because Q is based on asset prices determined in forward-looking markets, it should capture the prospective profitability of investment better than lags of past profits. That is, the past Q is based on asset price for forward-looking market, past Q (i.e., Q_{t-1}, Q_{t-2}) can affect near future investment (IK_t). Therefore, it is necessary to include Q_{t-1}, Q_{t-2} as instrumental variable inside the GMM estimators.

Whether the inclusion of these IVs ((1) CFK_{t-1}, CFK_{t-2}; (2) CFK_{t-1}, CFK_{t-2}, Q_{t-1}, Q_{t-2}) are over-identified or not would be validated by SARGAN-HANSEN test and also validated whether the variables are still exogenous after IVs treatment by DURBIN-WU-HAUSMAN test (see table A-7 and A-6 in *appendix*).

4.2.2.4.1 Analysis of test result of the hypotheses with GMM estimators

The proposal of this hypothesis (*H2a and H2b*) test is to compare the investment to cash flow sensitivity between crisis and post-crisis with the classification criteria of the firm's financing constraint. ARSLAN, FLORACKIS and OZBAS (2006) analyze the emerging market during pre-crisis and crisis to test the hypothesis whether the hedging role of cash is more critical for the region which is characterized by high asymmetric information and excessive costs of external finance. Their results demonstrate that financially constrained firms exhibit greater investment to cash flow sensitivities than unconstrained firms for crisis period.

Hence, this research hypothesizes (see chapter 3.5) that financially constrained have more investment to cash flow sensitivity during crisis than post-crisis (*H2a*) due to the characteristics in Brazil that firms' lack of access to long-term loans market makes firm managers depend more on internal funds for investment (PROCIANOY, 1994; PROCIANOY and CASELANI, 1997) and this research presumes that this tendencies are more severe during crisis than post-crisis for financially constrained firms. However, for unconstrained firms don't have more investment to cash flow sensitivity during crisis than post-crisis (*H2b*).

In the similar vein, financially constrained firms demonstrate more negative relationship between working capital and investment during crises comparing with post-crises

[44] see chapter 3.2.3 (1) for the reference

(*H2c*). Financially unconstrained firms don't demonstrate more negative relationship between working capital and investment during crises comparing with post-crises (*H2d*).

Table 16 presents the regression result of hypotheses (*H2a/ H2b/ H2c/ H2d*) which investigated investment to cash flow sensitivity and working capital relation to investment between crises and post-crisis with the three different criteria for the financially constrained firms (FCON) and financially unconstrained firms (FUNC) with the instrumental variable of two years lagged cash flow (CFK t-1, CFK t-2) for period 1998-2017.

To compare the investment to cash flow sensitivity and working capital relationship to investment, this thesis did separate regressions for crisis and post-crisis with instrumental variables for each criteria of FUNC and FCON to compare only when the coefficients of both periods demonstrate the statistical significances[45] with 1% and 5% (see Table 16).

To accomplish the objective of the comparison *H2*, the strategy of this research is 1) calculate the coefficient with the insertion of instrumental variables (GMM estimators); 2) compare the coefficients of those two periods (crisis and post-crises). This research adopt the comparison results obtained by GMM estimators only when 1) the significant level of both coefficients of variables of crisis and post-crisis period are less than $p<0.05$; 2) Robustness (Prob > chi2) of the GMM estimation results for both periods in the criteria are less than 0.1.

- ✓ ***IV estimations with CFK t-1 and CFK t-2***

According to these requirements, the regression results of three criteria as follows. Regarding the investment to cash flow sensitivity comparison (*H2a* and *H2b*), For FCON (*H2a*), no criteria and variables presented the significant level of coefficients for both crisis and post-crisis at the same comparison pairs of the criteria and financing constraint status. For FUNC (*H2b*), in contrary to the expecting signs, three criteria of coefficients of CFK demonstrated the significant differences between crises and post-crises: 1) payout / size (diff = 0.1033***); 2) cash / leverage (diff = -2.1462 **); 3) size / age (diff = -0.513***). In detail, payout / size (FUNC), coefficient (0.3195, $p<0.01$) of crisis is more positively sensitive than the coefficient (0.2162, $p<0.01$) of post-crisis. For cash / leverage (FUNC), coefficient (-2.293, $p<0.05$) of crisis is more negatively sensitive than coefficient (-0.0931, $p<0.01$) of post-crisis.

[45] *Esttab* command in STATA/IC *version* 14.2 can be used for GMM estimators to compare the coefficients of both periods, however, it does not demonstrate the statistical significance of the difference between both coefficients to be compared. Therefore, it is no better than manual comparison of the results on table 16.

Table 16 Regression result of hypotheses (H2a/ H2b/ H2c/ H2d) investment to cash flow sensitivity and working capital relation to investment between crises and post-crisis with the three different criteria for the financially constrained firms and financially unconstrained firms with the instrumental variable of lagged cash flow (CFK t-1 and CFK t-2) for period 1998-2017

Hypothesis	*H2a: Financially constrained firms present more investment to cash-flow sensitivity during crisis comparing with post-crisis.* *H2b: Financially unconstrained firms don't present more investment to cash-flow sensitivity during crisis comparing with post-crisis.* *H2c: Financially constrained firms demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis.* *H2d: Financially unconstrained firms don't demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis.*									
Equation	$\frac{I_{i,t}}{K_{i,t-1}} = \beta_0 + \beta_1 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_2 Q_{i,t} + \beta_3 \frac{\Delta WC_{i,t}}{Ki,t-1} + \beta_4 \text{Size}_{i,t} + \varepsilon it$									
IV	CFK t --> (CFK t-1, CFK t-2)									
Criteria	**TOTAL SAMPLE**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 1551 Wald chi2(4) = 1906.70 Prob > chi2 = 0.0000						Instrumental variables (GMM) Number of obs = 3674 Wald chi2(4) = 21.18 Prob > chi2 = 0.0003				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3427	0.0093	36.8300	0.0000		CFK	-0.2302	0.1191	-1.9300	0.0530	
Q	-0.1038	0.0372	-2.7900	0.0050		Q	0.0497	0.0355	1.4000	0.1610	
WCK	-0.1589	0.1105	-1.4400	0.1500		WCK	0.1128	0.0529	2.1300	0.0330	
size	-0.0203	0.0259	-0.7800	0.4330		size	0.1207	0.0293	4.1200	0.0000	
_cons	0.4573	0.1859	2.4600	0.0140		_cons	-0.1422	0.1607	-0.8900	0.3760	
Criteria	**PAYOUT / SIZE (FUNC)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 141 Wald chi2(4) = 276.57 Prob > chi2 = 0.0000						Instrumental variables (GMM) Number of obs = 314 Wald chi2(4) = 30.22 Prob > chi2 = 0.0000				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3195	0.0215	14.8900	0.0000		CFK	0.2162	0.0540	4.0000	0.0000	0.1033 ***
Q	-0.2948	0.0727	-4.0500	0.0000		Q	-0.2004	0.0444	-4.5100	0.0000	-0.2411 ***
WCK	-0.2554	0.1422	-1.8000	0.0720		WCK	0.0674	0.1163	0.5800	0.5620	
size	-0.1094	0.0452	-2.4200	0.0160		size	-0.0533	0.0759	-0.7000	0.4830	
_cons	1.3834	0.3675	3.7600	0.0000		_cons	1.0872	0.5152	2.1100	0.0350	
Criteria	**PAYOUT / SIZE (FCON)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 406 Wald chi2(4) = 17.24 Prob > chi2 = 0.0017						Instrumental variables (GMM) Number of obs = 948 Wald chi2(4) = 6.49 Prob > chi2 = 0.1657				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3508	0.1158	3.0300	0.0020		CFK	-0.0644	0.0506	-1.2700	0.2030	
Q	-0.0396	0.0407	-0.9700	0.3310		Q	0.0219	0.0233	0.9400	0.3470	
WCK	0.0073	0.1330	0.0600	0.9560		WCK	0.0272	0.0266	1.0200	0.3070	
size	-0.2339	0.1873	-1.2500	0.2120		size	0.0929	0.0438	2.1200	0.0340	
_cons	1.4410	0.9887	1.4600	0.1450		_cons	-0.1374	0.2354	-0.5800	0.5590	
Criteria	**CASH / LEVERAGE (FUNC)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 113 Wald chi2(4) = 7.99 Prob > chi2 = 0.0918						Instrumental variables (GMM) Number of obs = 375 Wald chi2(4) = 131.04 Prob > chi2 = 0.0000				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	-2.2393	1.0364	-2.1600	0.0310		CFK	-0.0931	0.0126	-7.4100	0.0000	-2.1462 **
Q	0.3523	0.2198	1.6000	0.1090		Q	0.0499	0.0376	1.3300	0.1840	
WCK	-1.2488	1.0451	-1.1900	0.2320		WCK	0.0787	0.0140	5.6100	0.0000	
size	0.2519	0.2079	1.2100	0.2260		size	0.0472	0.0221	2.1300	0.0330	
_cons	-0.6263	1.0996	-0.5700	0.5690		_cons	0.0784	0.1340	0.5800	0.5590	

(Continued from previous table)

Criteria	CASH / LEVERAGE (FCON)									
Classification	*Crisis*				*Post crisis*					
Instrumental variables (GMM) Number of obs = 142 Wald chi2(4) = 8.79 Prob > chi2 = 0.0666					Instrumental variables (GMM) Number of obs = 298 Wald chi2(4) = 9.35 Prob > chi2 = 0.0528					Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z	IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.0911	0.0616	1.4800	0.1390	CFK	-0.0391	0.7214	-0.0500	0.9570	
Q	-0.0620	0.0447	-1.3900	0.1650	Q	-0.0166	0.0374	-0.4400	0.6570	
WCK	-0.1303	0.0767	-1.7000	0.0890	WCK	-0.0251	0.2881	-0.0900	0.9300	
size	0.0949	0.0430	2.2100	0.0270	size	-0.0054	0.0351	-0.1600	0.8770	
_cons	-0.2162	0.2559	-0.8400	0.3980	_cons	0.4751	0.4379	1.0800	0.2780	
Criteria	FIRM SIZE / FIRM AGE (FUNC)									
Classification	*Crisis*				*Post crisis*					
Instrumental variables (GMM) Number of obs = 167 Wald chi2(4) = 19.03 Prob > chi2 = 0.0008					Instrumental variables (GMM) Number of obs = 380 Wald chi2(4) = 55.41, Prob > chi2 = 0.0000					Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z	IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.2729	0.0775	3.5200	0.0000	CFK	0.7862	0.1224	6.4200	0.0000	-0.5133 ***
Q	-0.2624	0.0890	-2.9500	0.0030	Q	-0.3955	0.2373	-1.6700	0.0960	
WCK	-0.2475	0.1547	-1.6000	0.1100	WCK	-0.2656	0.1924	-1.3800	0.1680	
size	-0.2370	0.0821	-2.8900	0.0040	size	-0.0151	0.0518	-0.2900	0.7710	
_cons	2.4530	0.7111	3.4500	0.0010	_cons	0.4326	0.2930	1.4800	0.1400	
Criteria	FIRM SIZE / FIRM AGE (FCON)									
Classification	*Crisis*				*Post crisis*					
Instrumental variables (GMM) Number of obs = 148 Wald chi2(4) = 15.01 Prob > chi2 = 0.0047					Instrumental variables (GMM) Number of obs = 321 Wald chi2(4) = 8.84, Prob > chi2 = 0.0652					Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z	IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.0580	0.0966	0.6000	0.5490	CFK	-0.0579	0.0514	-1.1300	0.2600	
Q	-0.0345	0.0366	-0.9400	0.3470	Q	-0.0064	0.0391	-0.1600	0.8710	
WCK	0.0505	0.0487	1.0400	0.2990	WCK	0.0588	0.0288	2.0400	0.0410	
size	0.1820	0.0735	2.4800	0.0130	size	0.0822	0.0405	2.0300	0.0420	0.0998 **
_cons	-0.6606	0.3517	-1.8800	0.0600	_cons	-0.0274	0.2406	-0.1100	0.9090	

DEP = Dependent variable; _cons : constant; GMM = Generalized Method of Moment; IV = instrumental variable; the result of this regression is obtained by using GMM estimator to solve the endogeneity. The command of STATA/IC version 14.2 is "ivregress gmm [variables (instrumented (CFK t) = instrumental variables (CFK t-1 CFK t-2_)] vce (robust)" with two period lags of cash flow (FAZZARI, HUBBARD and PETERSEN, 1988). After adapting GMM, the endogeneity problem disappeared (command in STATA/IC version 14.2: estat endogenous: see the left hand side of Appendix table A- 6).

Source: author

However, the Wald chi2 of estimator result of crisis is not significant with $p<0.05$ (prob>chi2 = 0.09), but, significant with $p<0.1$. For size / age (FUNC), coefficient (0.2729, $p<0.01$) of crisis is less sensitive than coefficient (0.7862, $p<0.01$) of post-crisis. All three results of FUNC firms are contrary to the expecting sign (chapter 3.5) of "no investment to cash flow sensitivity for FUNC firms" between crisis and post-crisis. However, the coefficient difference of cash / leverage of FUNC between two periods are big enough (-2.1462).[46]

[46] Because the statistical difference of coefficients between crises and post-crises is not validated by the system, the difference mentioned here is said to be subjective even this study compares the significant coefficients. However, this doubt would be validated by the different method which demonstrate the statistical significant of the differences of coefficients between crises and post-crises in next chapter 4.2.3.

About the hypothesis test of *H2c* and *H2d* that whether financially constrained firms and unconstrained firms demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis or not. About the results, no criteria of FCON or FUNC demonstrate significant results to compare between crisis and post-crisis and it was unable to compare.

In summary, for IV estimations with CFK *t-1* and CFK *t-2*, only H2b were able to compare the coefficient between crises and post-crises, two criteria (pay / size and cash / leverage) of financially unconstrained firms in Brazil presented the significant differences of investment to cash flow sensitivity and more sensitive during crises comparing with post-crises.

- ✓ ***IV estimations with CFK t-1, CFK t-2, Q t-1 and Q t-2***

Meanwhile, for the robustness of the results obtained by IVs (CFK *t-1*, CFK *t-2*), this study also add more IVs (Q t-1, Q -2) repeated same test. Regarding the investment to cash flow sensitivity comparison (*H2a* and *H2b*) on Table 17, unlike the previous GMM estimators which IV is CFK *t-1* and CFK *t-2*, for FCON (*H2a*), one criteria (payout / size) of CFK (diff = 0.4978***) presented the significant differences of coefficients for both crisis and post-crisis at the same comparison pairs. In detail, payout / size (FCON), coefficient (0.3961, p<0.01) of crises is more positively sensitive than the coefficient (-0.1017, p<0.01) of post-crisis. It is consistent with the hypothesis of *H2a*. For FUNC (*H2b*), payout / size of CFK (diff = 0.0793***) with the coefficient (0.3011, p<0.01) of crisis is more positively sensitive than the coefficient (0.2218, p<0.01) of post-crisis in contrary to the expecting sign (chapter 3.5) of H2b.

About the hypothesis test of *H2c and H2d* that whether financially constrained firms and unconstrained firms demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis, only total sample presents (CFK (diff) = -0.3713***) with the coefficient (-3.052, p<0.01) of crisis is more negatively sensitive than the coefficient (0.0661, p<0.01) of post-crisis. About the result of H2c and H2d, also no criteria of FUNC and FUNC demonstrate significant results to compare between crisis and post-crisis.

Table 17 Regression result of hypotheses (H2a/ H2b/ H2c/ H2d) investment to cash flow sensitivity and working capital relation to investment between crises and post-crisis with the three different criteria for the financially constrained firms and financially unconstrained firms with the instrumental variable of lagged cash flow (CFK t-1 and CFK t-2) and lagged Q (Q t-1 and Q t-2) for the period 1998-2017

Hypothesis	*H2a: Financially constrained firms present more investment to cash-flow sensitivity during crisis comparing with post-crisis.* *H2b: Financially unconstrained firms don't present more investment to cash-flow sensitivity during crisis comparing with post-crisis.* *H2c: Financially constrained firms demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis.* *H2d: Financially unconstrained firms don't demonstrate more negative relationship between working capital and investment during crisis comparing with post-crisis.*									
Equation	$\frac{I_{i,t}}{K_{i,t-1}} = \beta_0 + \beta_1 \frac{CF_{i,t}}{K_{i,t-1}} + \beta_2 Q_{i,t} + \beta_3 \frac{\Delta WC_{i,t}}{Ki_{,t-1}} + \beta_4 \text{Size}_{i,t} + \varepsilon it$									
IV	CFK t --> (CFK t-1, CFK t-2), Qt --> (Q t-1, Q t-2)									
Criteria	**TOTAL SAMPLE**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 1551 Wald chi2(4) = 2506.57 Prob > chi2 = 0.0000						Instrumental variables (GMM) Number of obs = 3674 Wald chi2(4) = 261.51 Prob > chi2 = 0.0000				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3396	0.0076	44.7200	0.0000		CFK	-0.1203	0.0108	-11.1400	0.0000	0.4599 ***
Q	-0.1138	0.0270	-4.2100	0.0000		Q	0.0146	0.0235	0.6200	0.5340	
WCK	-0.3052	0.0835	-3.6500	0.0000		WCK	0.0661	0.0115	5.7600	0.0000	-0.3713 ***
size	0.0095	0.0249	0.3800	0.7030		size	0.1043	0.0171	6.0800	0.0000	
_cons	0.2604	0.1748	1.4900	0.1360		_cons	-0.0781	0.1132	-0.6900	0.4900	
Criteria	**PAYOUT / SIZE (FUNC)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 141 Wald chi2(4) = 91.30 Prob > chi2 = 0.0000						Instrumental variables (GMM) Number of obs = 314 Wald chi2(4) = 36.35 Prob > chi2 = 0.0000				Comparison
IK (Dep)	Coef.	Std. Err.	z	P>z		IK (Dep)	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3011	0.0358	8.4100	0.0000		CFK	0.2218	0.0502	4.4200	0.0000	0.0793 ***
Q	-0.2276	0.0396	-5.7400	0.0000		Q	-0.2024	0.0446	-4.5400	0.0000	-0.0252 ***
WCK	-0.2579	0.1371	-1.8800	0.0600		WCK	0.0745	0.1146	0.6500	0.5160	
size	-0.1049	0.0459	-2.2900	0.0220		size	-0.0590	0.0745	-0.7900	0.4280	
_cons	1.2792	0.3548	3.6100	0.0000		_cons	1.1239	0.5129	2.1900	0.0280	
Criteria	**PAYOUT / SIZE (FCON)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 406 Wald chi2(4) = 22.84 Prob > chi2 = 0.0001						Instrumental variables (GMM) Number of obs = 948 Wald chi2(4) = 20.14 Prob > chi2 = 0.0005				Comparison
IK	Coef.	Std. Err.	z	P>z		IK	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.3961	0.1394	2.8400	0.0040		CFK	-0.1017	0.0261	-3.8900	0.0000	0.4978 ***
Q	-0.0710	0.0512	-1.3900	0.1650		Q	-0.0757	0.0460	-1.6500	0.0990	
WCK	-0.0618	0.1118	-0.5500	0.5810		WCK	0.0281	0.0178	1.5800	0.1150	
size	-0.2136	0.2007	-1.0600	0.2870		size	0.0781	0.0467	1.6700	0.0940	
_cons	1.3424	1.0630	1.2600	0.2070		_cons	0.0491	0.2662	0.1800	0.8540	
Criteria	**CASH / LEVERAGE (FUNC)**									
Classification	*Crisis*					*Post crisis*				
Instrumental variables (GMM) Number of obs = 113 Wald chi2(4) = 3.01 Prob > chi2 = 0.5563						Instrumental variables (GMM) Number of obs = 375 Wald chi2(4) = 198.08 Prob > chi2 = 0.0000				Comparison
IK	Coef.	Std. Err.	z	P>z		IK	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	-2.2715	1.4632	-1.5500	0.1210		CFK	-0.0970	0.0137	-7.0600	0.0000	
Q	-0.1927	0.2910	-0.6600	0.5080		Q	0.3055	0.1881	1.6200	0.1040	
WCK	-1.1891	1.2501	-0.9500	0.3420		WCK	0.0840	0.0180	4.6800	0.0000	
size	0.2437	0.2303	1.0600	0.2900		size	0.0383	0.0267	1.4300	0.1530	
_cons	-0.1431	1.0798	-0.1300	0.8950		_cons	-0.2579	0.2341	-1.1000	0.2710	

(Continued from previous table)

Criteria	CASH / LEVERAGE (FCON)								
Classification	*Crisis*				*Post crisis*				
Instrumental variables (GMM) Number of obs = 142 Wald chi2(4) = 10.58 Prob > chi2 = 0.0317					Instrumental variables (GMM) Number of obs = 298 Wald chi2(4) = 1.81 Prob > chi2 = 0.7698				Comparison
IK	Coef.	Std. Err.	z	P>z	IK	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.1187	0.0625	1.9000	0.0580	CFK	0.5722	0.6614	0.8700	0.3870	
Q	-0.0772	0.0428	-1.8000	0.0710	Q	-0.0470	0.1413	-0.3300	0.7390	
WCK	-0.1686	0.0768	-2.1900	0.0280	WCK	-0.2775	0.3217	-0.8600	0.3880	
size	0.0914	0.0444	2.0600	0.0390	size	-0.0070	0.0474	-0.1500	0.8830	
_cons	-0.1965	0.2527	-0.7800	0.4370	_cons	0.1269	0.2572	0.4900	0.6220	
Criteria	FIRM SIZE / FIRM AGE (FUNC)								
Classification	*Crisis*				*Post crisis*				
Instrumental variables (GMM) Number of obs = 167 Wald chi2(4) = 16.24 Prob > chi2 = 0.0027					Instrumental variables (GMM) Number of obs = 380 Wald chi2(4) = 40.47, Prob > chi2 = 0.0000 R				Comparison
IK	Coef.	Std. Err.	z	P>z	IK	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.2737	0.0858	3.1900	0.0010	CFK	0.0676	0.1033	0.6500	0.5130	
Q	-0.2198	0.1339	-1.6400	0.1010	Q	0.0963	0.1473	0.6500	0.5130	
WCK	-0.2626	0.1589	-1.6500	0.0980	WCK	0.0847	0.1408	0.6000	0.5480	
size	-0.2083	0.0763	-2.7300	0.0060	size	-0.1694	0.0386	-4.3900	0.0000	
_cons	2.1661	0.6575	3.2900	0.0010	_cons	1.6552	0.3075	5.3800	0.0000	
Criteria	FIRM SIZE / FIRM AGE (FCON)								
Classification	*Crisis*				*Post crisis*				
Instrumental variables (GMM) Number of obs = 148 Wald chi2(4) = 20.17 Prob > chi2 = 0.0005					Instrumental variables (GMM) Number of obs = 321 Wald chi2(4) = 272.77; Prob > chi2 = 0.0000				Comparison
IK	Coef.	Std. Err.	z	P>z	IK	Coef.	Std. Err.	z	P>z	(crisis) - (post-crisis)
CFK	0.1318	0.1469	0.9000	0.3700	CFK	-0.1171	0.0143	-8.2100	0.0000	
Q	-0.0153	0.0369	-0.4100	0.6780	Q	-0.2323	0.1920	-1.2100	0.2260	
WCK	0.0648	0.0757	0.8600	0.3920	WCK	0.0345	0.0231	1.5000	0.1350	
size	0.1114	0.0621	1.7900	0.0730	size	-0.0257	0.1147	-0.2200	0.8230	
_cons	-0.3883	0.3247	-1.2000	0.2320	_cons	0.8710	0.8017	1.0900	0.2770	

DEP = Dependent variable; _cons : constant; GMM = Generalized Method of Moment; IV = instrumental variable; the result of this regression is obtained by using GMM estimator to solve the endogeneity. The command of STATA/IC 14.2 is "ivregress gmm [variables (instrumented (CFK t Qt) = instrumental variables (CFK t-1 CFK t-2 Qt-1 Qt-2)], vce (robust)" with two period lags of cash flow (FAZZARI, HUBBARD and PETERSEN, 1988). After adapting GMM, the endogeneity problem disappeared (command in STATA/IC version 14.2: estat endogenous: see the right side of Appendix table A- 6).

Source: author

After performing the comparison of coefficients of GMM estimators with instrumental variables, to check whether endogeneity problem were solved, endogenous tests[47] (Table A-6 in *appendix*) for the IV regression were done. All the criteria of IV estimation with CFK t-1 and CFKt-2 present no endogeneity. However, some criteria of IV estimation (CFK t-1, CFKt-2, Q t-1, Qt-2) still present endogeneity: 1) total sample (p=0.002); 2) payout / size of FCON (p=0.013), CASH; 3) size / age of FCON (p=0.035). Also, for over-identifying restriction test[48], SARGAN-HANSEN test results (Table A-7 in *appendix*) indicated whether the employed

[47] STATA IC 14.2 command (*estat endogenous* after the execution of *ivregrss*)

[48] STATA IC 14.2 command (*estat overid*)

instruments are valid or not (H0: overidentifying restrictions are valid). All three criteria of IV estimator (CFK t-1, CFKt-2) present no overidentifying restriction, that is, p-value is above threshold of 0.05. Whereas, for the IV regression with CFK t-1, CFKt-2, Q t-1, Qt-2, payout of FCON criteria presents overidentifying restriction which p-value is below 0.05 (p = 0.003). Therefore, some of IV estimators with CFK t-1, CFKt-2, Q t-1, Qt-2 still presents both endogeneity problem and overidentifying restriction problems, hence, this research didn't adopt (disregard) the results of Table 17.

4.2.3 Supplementary test of H2 with bivariate regression (with SUEST *command*)

Because the previous results of *H2* on table 16 with GMM estimators were done by manual way with the comparison of the differences of coefficients between crisis and post-crisis only for the criteria which coefficients are considered as statistically significant. Hence, the coefficients between crises and post-crises in H2a, H2c and H2d on table 16 cannot be compared due to the lack of statistical significance, at least, one period of the criteria. The result of GMM estimators in H2b needs be also confirmed by the bivariate regression.

Therefore, to supplement the lack of systematical comparison on previous results (table 16), it is necessary to have a comparison method which systematically demonstrate the significance levels of differences of coefficients between crises and post-crises with statistical significances in the system STATA. Even dynamic panel data is preferred for this study (see 4.2.2.3) than pooled OLS, the comparison results provided by the bivariate regression and *SUEST* [49] option in STATA/IC *version* 14.2 presents the statistical significances systematically. Hence, bivariate regression analysis were additionally performed to relate two variables (IK and CFK (H2a and H2b); IK and WCK (H2c and H2d)).

[49] STATA/IC *version* 14.2 command *SUEST* can compare the coefficients of explanatory variable between crisis (*A*) and post-crisis (*B*). For example, in relation of IK and CFK, the comparison procedure is as follow: 1) *regress* two variables (*IK* and *CFK*) in STATA for crisis and post-crisis separately and store each estimation as A and B; 2) demonstrate the means and differences between two periods with the command of *SUEST A B*; 3) use command *test [A_mean]CFK =[B_mean]CFK* to validate (demonstrate p-value of difference of coefficients) whether two coefficients are different from zero.

Table 18 Supplementary test with bivariate regressions for hypotheses (H2a/ H2b) comparing the differences of investment to cash flow sensitivity between crises and post-crisis with the three different criteria for the financially constrained firms and financially unconstrained firms for the periods from 1998 to 2017

TOTAL SAMPLE

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	CFK	0.1237	0.0562	2.2000	0.0280
	_cons	0.3449	0.0385	8.9700	0.0000
(B) Mean of post-crisis	CFK	0.0210	0.0136	1.5400	0.1230
	_cons	0.4745	0.0183	25.9100	0.0000
[A_mean]CFK - [B_mean]CFK = 0					
chi2 (1):	3.1600		Prob > chi2	0.0754	

PAYOUT / SIZE

FUNC						FCON					
		Coef.	Std. Err.	z	P>z			Coef.	Std. Err.	z	P>z
(A) Mean of crisis	CFK	0.2013	0.0771	2.6100	0.0090	(A) Mean of crisis	CFK	-0.0521	0.0913	-0.5700	0.5680
	_cons	0.3344	0.0882	3.7900	0.0000		_cons	0.3136	0.0482	6.5100	0.0000
(B) Mean of post-crisis	CFK	0.1772	0.0403	4.3900	0.0000	(B) Mean of post-crisis	CFK	-0.0095	0.0140	-0.6800	0.4960
	_cons	0.4727	0.0725	6.5200	0.0000		_cons	0.3299	0.0295	11.1900	0.0000
[A_mean]CFK - [B_mean]CFK = 0						[A_mean]CFK - [B_mean]CFK = 0					
chi2 (1):	0.0800		Prob > chi2	0.7820		chi2 (1):	0.2100		Prob > chi2	0.6451	

CASH / LEVERAGE

FUNC						FCON					
		Coef.	Std. Err.	z	P>z			Coef.	Std. Err.	z	P>z
(A) Mean of crisis	CFK	-0.3945	0.0904	-4.3600	0.0000	(A) Mean of crisis	CFK	-0.0083	0.0172	-0.4800	0.6300
	_cons	0.5559	0.0763	7.2800	0.0000		_cons	0.3463	0.0619	5.5900	0.0000
(B) Mean of post-crisis	CFK	-0.0624	0.0465	-1.3400	0.1790	(B) Mean of post-crisis	CFK	-0.0362	0.0406	-0.8900	0.3720
	_cons	0.4835	0.0522	9.2600	0.0000		_cons	0.4575	0.0460	9.9400	0.0000
[A_mean]CFK - [B_mean]CFK = 0						[A_mean]CFK - [B_mean]CFK = 0					
chi2 (1):	10.6600		Prob > chi2	**0.0011**		chi2 (1):	0.4000		Prob > chi2	0.5263	

FIRM SIZE / FIRM AGE

FUNC						FCON					
		Coef.	Std. Err.	z	P>z			Coef.	Std. Err.	z	P>z
(A) Mean of crisis	CFK	0.1380	0.0392	3.5200	0.0000	(A) Mean of crisis	CFK	-0.0052	0.0326	-0.1600	0.8740
	_cons	0.5003	0.0832	6.0200	0.0000		_cons	0.2469	0.0459	5.3800	0.0000
(B) Mean of post-crisis	CFK	0.2052	0.0543	3.7800	0.0000	(B) Mean of post-crisis	CFK	-0.0029	0.0158	-0.1900	0.8530
	_cons	0.4003	0.0653	6.1300	0.0000		_cons	0.3416	0.0639	5.3400	0.0000
[A_mean]CFK - [B_mean]CFK = 0						[A_mean]CFK - [B_mean]CFK = 0					
chi2 (1):	1.0100		Prob > chi2	0.3157		chi2 (1):	0.0000		Prob > chi2	0.9509	

CFK = EBITDA t / K t-1; _cons = constant.

Source: author

Table 18 presents the comparison results with bivariate regressions for each criteria of FCON and FUNC. Only cash / leverage of FUNC demonstrates significant differences of investment to cash flow sensitivity between two periods (-0.33, more negatively sensitive, $p<0.01$). It is not consistent with the expecting sign of H2b, however it presents similar result with the comparison of GMM estimators in table 16. Other criteria of H2b is consistent with expecting sign (not consistent). For H2a (FCON), there are no significant differences of investment to cash flow sensitivity between crises and post-crises. It is also not consistent with expecting signs of H2a.

Table 19 Supplementary test with bivariate regressions for hypotheses (H2c/ H2d) comparing the differences of working capital relation to investment between crises and post-crisis with the three different criteria for the financially constrained firms and financially unconstrained firms for the periods from 1998 to 2017

TOTAL SAMPLE

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.0037	0.0462	0.0800	0.9350
	_cons	0.4160	0.0197	21.1200	0.0000
(B) Mean of post-crisis	WCK	0.0164	0.0154	1.0700	0.2860
	_cons	0.4900	0.0144	33.9800	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1)	0.0700		Prob > chi2	0.7953	

PAYOUT / SIZE

FUNC

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.0305	0.1609	0.1900	0.8490
	_cons	0.6276	0.0764	8.2100	0.0000
(B) Mean of post-crisis	WCK	0.2216	0.1151	1.9200	0.0540
	_cons	0.7260	0.0688	10.5600	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	0.9300		Prob > chi2	0.3340	

FCON

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.0468	0.0770	0.6100	0.5430
	_cons	0.3023	0.0342	8.8500	0.0000
(B) Mean of post-crisis	WCK	-0.0017	0.0171	-0.1000	0.9230
	_cons	0.3249	0.0298	10.8900	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	0.3800		Prob > chi2	0.5388	

CASH / LEVERAGE

FUNC

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.4779	0.0880	5.4300	0.0000
	_cons	0.3502	0.0685	5.1100	0.0000
(B) Mean of post-crisis	WCK	0.0581	0.0270	2.1500	0.0310
	_cons	0.4076	0.0360	11.3100	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	20.7700		Prob > chi2	**0.0000**	

FCON

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	-0.0328	0.0148	-2.2100	0.0270
	_cons	0.3309	0.0615	5.3800	0.0000
(B) Mean of post-crisis	WCK	-0.0665	0.0102	-6.5200	0.0000
	_cons	0.3701	0.0373	9.9200	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	3.5100		Prob > chi2	0.0612	

FIRM SIZE / FIRM AGE

FUNC

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.1007	0.1155	0.8700	0.3840
	_cons	0.6408	0.0797	8.0400	0.0000
(B) Mean of post-crisis	WCK	0.1481	0.1332	1.1100	0.2660
	_cons	0.6475	0.0518	12.5000	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	0.0700		Prob > chi2	0.7881	

FCON

		Coef.	Std. Err.	z	P>z
(A) Mean of crisis	WCK	0.0503	0.0388	1.3000	0.1950
	_cons	0.2458	0.0439	5.5900	0.0000
(B) Mean of post-crisis	WCK	0.0457	0.0362	1.2600	0.2070
	_cons	0.3104	0.0483	6.4200	0.0000
[A_mean]WCK - [B_mean]WCK= 0					
chi2 (1):	0.0100		Prob > chi2	0.9320	

WCK = ((CA-CL) t / K t-1); _cons = constant.

Source: author

On Table 19, regarding the working capital relationship to investment, cash / leverage of FUNC presents the significant difference between crisis and post-crisis with (0.42, more positive relation, $p<0.01$), however, it is not consistent with H2d which FCON don't demonstrate more negative relationship between working capital and investment during crisis comparing with post-crises. Also, for FCON (H2c), no criteria show significant evidences regarding the difference of investment relationship to working capital between crises and post-crises. It is not consistent with the expectation of more negative relation during crisis.

4.3 Summary of principal evidences of *H1* and *H2*

Table 20 summarizes all the test result of *H1* and *H2*. The test result of first hypothesis whether there are differences of investment, growth opportunity and cash generation between crisis and post-crisis. For financially constrained firms, in contrary to the expecting sign of this research, only one criterion (intersection of payout and size) presented the significant difference (reduction) of growth opportunity proxied by Q during crisis comparing with post-crises. In addition, no other criteria of investment and cash generation of financially constrained firms present the significant differences between two periods.

However, for financially unconstrained firms, except two criteria (intersection of cash and leverage; size and age) of growth opportunity (Q), one criteria (intersection of payout and size) of growth opportunity and all other criteria of financially unconstrained firms demonstrated significant differences between two periods as expected by the *H1b*. For the response of the question of *H1* whether there are difference between crises and post-crises regardless of the expecting sign, only growth opportunity of financially unconstrained firms in Brazil present the statistically significant differences between crises and post-crises.

Second hypothesis were tested with GMM (Generalized Method of Moments) estimators to compare investment to cash flow sensitivity and working capital relation to investment between crises and post-crises. For the comparison of investment to cash flow sensitivity between crises and post-crises, financially constrained firms demonstrate that the coefficients of all the criteria for both periods are not significant to compare the difference of the sensitivities. Whereas, all the criteria of financially unconstrained firms demonstrate the significant coefficients of investment to cash flow sensitivities for both periods, however, regarding the comparison of the coefficients between crises and post-crises, one criteria with intersection of cash and leverage demonstrate very different investment to cash flow sensitivity (-2.14, $p<0.05$) during crises comparing with post-crises even this more sensitivity during crises is not consistent with the expecting sign.

For the comparison of working capital relation between crises and post-crises, the coefficients of all the criteria for both periods are not significant to compare the differences of the relations. These results are not consistent with FAZZARI and PETERSEN (1993)'s argument that working capital and investment compete within a limited pool of finance.

As an alternative way to supplement the manual comparison of the coefficients by GMM estimators which don't provide systematic statistical significance of the differences

between two periods, bivariate regression were used to validate that the coefficients of both periods are significantly different for H2a, H2c and H2d which comparison are not able in GMM estimators (H2b results were also confirmed by this method). With this method, the comparison results of crises and post-crises present that financially constrained firms (H2a and H2c) demonstrated the insensitivities for both investment to cash flow and investment to working capital and these insensitivities are in contrary to expecting sign.

For unconstrained firms (H2d), the intersection of cash and leverages demonstrated the significant working capital relations to investment (0.42, $p<0.05$) which is not according to the expecting sign, other two criteria of FUNC (H2d) presents "not significant" difference between crises and post-crises as expected. In addition, for the validation check (H2b) of the previous results obtained by the comparison of GMM estimators between crises and post-crises, financially unconstrained firms with the criteria of cash / leverage also demonstrates the differences of investment to cash flow sensitivity (-0.33, $p<0.05$) between crises and post-crises which reveals that FAZZARI, HUBBARD and PETERSEN (1988); KAPLAN and ZINGALES (1997)'s theory of less constrained firms' more investment to cash flow sensitivity can be applied for the high cash and low leverage firms during crises period comparing with post-crises. For *H2*, with the supplementary strategy of two methods (GMM estimators and bivariate regression), the validation of the difference between crises and post-crises regarding the relations could be achieved. However, even with two methods for the empirical test of *H2*, the differences of investment to cash flow sensitivity and working capital relation between crises and post-crises cannot be observed for financially constrained firms. For financially unconstrained firms, only one criteria demonstrate the difference of the sensitivity and relation, but, it may not be sufficient to provide the firm evidence of such differences which this thesis looks for.

In conclusion, the empirical test results of two hypotheses for Brazilian firms do not provide any definite evidences that there are differences of variables and sensitivities between crises and post-crises period as other corporate finance theories argue. Moreover, these indifferences are even greater for financially constrained firms in contrary to expecting sign of this thesis.

Table 20 Summary of *H1* and *H2* results (Expecting signs versus the results)

H1

1) t-test results

Expecting sign					Test result						
					IK		Q		CFK		
Hypot-hesis	Financing constraint	Variables	Mean of variable	Difference of mean of variable between crisis and post-crisis	difference	p-value	difference	p-value	difference	p-value	Criteria
H1a	FCON	IK, Q, CFK	C ≠ PC	significant	N/S		-0.22202	***Pay/size	N/S		**Pay/Size**
							N/S				**Cash/Leverage**
											Size/Age
H1b	FUNC	IK, Q, CFK	C =PC	not significant	N/S		N/S		N/S		**Pay/Size**
							-0.51181	***cash/lev			**Cash/Leverage**
							-0.18272	**size/age			**Size/Age**

H2

1) Comparisons of coefficients of GMM estimators (IV : CFK t-1, CFK t-2) between crisis and post-crisis

Expecting sign						Test result						
						pay/size		cash/lev		size/age		Adoption of each result for this thesis
Hypot-hesis	Financing constraint	Dependent variables	Explanatory variable	Coefficient	Difference of coefficients between crisis and post-crisis	difference	p-value	difference	p-value	difference	p-value	
H2a	FCON	IK	CFK	C ≠ PC	More sensitive during crisis	N/A		N/A		N/A		**No**
H2b	FUNC			C =PC	not significant	0.1033	***	-2.1462	**	-0.5133	***	**Yes**
H2c	FCON	IK	WCK	C ≠ PC	More negative during crisis	N/A		N/A		N/A		**No**
H2d	FUNC			C =PC	not significant	N/A		N/A		N/A		**No**

2) Alternative method for *"N/A"* (*mean difference check with bivariate regression between* crisis and post-crisis)

Expecting sign						Test result						
						pay/size		cash/lev		size/age		Adoption of each result for this thesis
Hypot-hesis	Financing constraint	Dependent variables	Explanatory variable	Coefficient	Difference of coefficients between crisis and post-crisis	difference	p-value	difference	p-value	difference	p-value	
H2a	FCON	IK	CFK	C ≠ PC	More sensitive during crisis	N/S		N/S		N/S		**Yes**
H2b	FUNC			C =PC	not significant	N/S		-0.3321	***	N/S		**confirm (cash/lev)**
H2c	FCON	IK	WCK	C ≠ PC	More negative during crisis	N/S		N/S		N/S		**Yes**
H2d	FUNC			C =PC	not significant	N/S		0.4197	***	N/S		**Yes**

Grey colored column means that the result is consistent with the expecting sign; N/S = comparison difference of coefficients is not significant; N/A = coefficient for the comparison is not significant; C= Crisis: PC = Post-crisis; CFK = (Cash Flow t/K (capital stock) t-1); IK = (acquisition of PPE t / K t-1); WCK = ((CA-CL) t / K t-1); FUNC= financially unconstrained firms; FCON = financially constrained firms.

Source: author

5 Final Consideration

This thesis aims to investigate empirically whether there are differences in investments, growth opportunities and cash generation between crises and post-crisis periods for Brazilian firms. However, considering the recurrent crises, it was a doubtful question if there are some dilutions of these differences of the aforementioned variables which are also dependent on firm's financing constraint status.

At the time of the conclusion of this thesis (2019), Brazil still suffers with foreign exchange rate variation volatility, it may be due to the global synchronization with the economic situation of emerging countries, or may be due to the lack of the confidences from foreign investors who are watching the political issue of new government such as reformation of pensions which affect the expenditure of government.

Since FAZZARI, HUBBARD and PETERSEN (1988) shed a light on financing constraint and corporate investment, there had been many literature (ALMEIDA, CAMPELLO et al.) follow-up their study and debate (KAPLAN and ZINGALES, 1997, FAZZARI, HUBBARD and PETERSEN (2000), KAPLAN and ZINGALES, 2000) until 2010. Since CAMPELLO, GRAHAM and HARVEY (2010) treated financing constraint and financial crisis, thereafter, during the decade of 2010, financial flexibility studies (ARSLAN, FLORACKIS and OZKAN, 2006; ARSLAN, FLORACKIS and OZKAN, 2010; BANCEL and MITTO 2011; BYOUN, 2011; DEANGELO, GONÇALVES AND STULZ, 2016; DUCHIN, OZBAS and SENSOY, 2010; MARCHICA and MURA, 2010) have prevailed due to the occurrence of frequent crisis and the synchronization of global economy.

After Asian Crisis (from 1997 to 1998), managers concern about financial flexibility which is known as the ability of a firm to respond effectively to unanticipated exogenous shocks to its cash flows or its investment opportunities. Since MODIGLIANI and MILLER (1958), corporate investment has been believed as the vehicle of firm's growth, and the academic research have been studied financing decision and cost of funds for investment. However, repeated crisis brought the concern of firm's manager to focus more the survival of firms. Therefore, this thesis assumed that financing constrained firms and financially unconstrained firms react differently between crisis and post-crisis regarding the investment and growth opportunity.

This thesis theoretically approaches that financially constrained firms and unconstrained firms suffer with different kind of problem. Financially unconstrained firms may have free cash flow (JENSEN, 1986) to disgorge, however, during crisis, this free cash flow can make firms to be flexible to payout or invest. This is why this thesis hypothesizes that financially unconstrained firms present similar level of investment, growth opportunity and cash generation between crises and post-crises. Whereas, financially constrained firms are apt to be suffered with asymmetric information which worsen their financial condition (BERNANKE, GERTLER and GILCHRIST, 1996) to result in the lack of external funds to invest if internal funds are not sufficient due to high cost wedge between internal and external funds. Therefore, this thesis hypothesizes that financially constrained firms present more reduction of investment, growth opportunity and cash generation during crisis comparing post-crises.

Methodologically, to respond the objective of this research, two different empirical strategies were made. For the first hypothesis, t-test was applied to investigate whether financially constrained firms or financially unconstrained firms reduce their investments, growth opportunities and cash generation during crises comparing with post-crises. For the second hypothesis, to investigate whether financially constrained firms or financially unconstrained firms demonstrate different investment to cash-flow sensitivity and working capital relations to investment between crises and post-crisis, dynamic panel data with GMM estimators were applied due to known endogeneity problem of reduced form investment equation and thereafter another bivariate regressions were performed to supplemented the comparison which lacked in GMM estimators.

The overall test results reveals that, except Q, there are a little differences of investment, cash generation, investment to cash flow sensitivity and working capital relation to investment between crisis and post-crisis, especially for financially constrained firms. This is in contrary to the expected signal of this thesis. However, notable facts are that, referring the yearly descriptive analysis of variables from 1998 to 2017 in Brazilian firms on table 9, investment lagged by capital stock (IK) was peaked in 2007 (0.719) and reduced to 0.281 after ten years (2017). Also, cash flow lagged by capital stock (CFK) reduced from 1.311 (2007) to 0.561 (2017). Whereas, Q moved less from 1.72 (2007) to 1.40 (2017) comparing with other two variables.

Conjecturing from test result of hypothesis of this thesis and the yearly descriptive analysis, this phenomena may reveal that 1) crisis effect for investment and cash flow is diluted (no

difference) for constrained and unconstrained firms; 2) possibility that the corporate investment and the related financing is not any more priority for firm's manager in Brazil. Instead, the effort to maintain firm value has been more important mission with the financial flexibility. These status is similar to ARSLAN, FLORACKIS and OZBAS (2010)'s descriptive analysis reveals that investment, Q and cash flow fall down after onset of Asian crisis and these drop didn't recover the pre-crises level until 2009 in Asian firms.

If this thesis responded the raised problem in chapter 1.1 properly, "not knowing these differences can cause underinvestment, or excessive free cash flow which can generate agency problem for the precautious managers of financially constrained firms and unconstrained firms in different ways in Brazil", the contribution of this thesis would be the elimination of the managers' concern which may underinvestment and low cash generation during crisis comparing with post-crisis for both constrained and unconstrained firm because most of the criteria of this study don't demonstrate statistically significant differences between crisis and post-crises. Also, the differences of investment relations to cash flow and working capital between crises and post-crises are not significant for most of the criteria of constrained and unconstrained firms, hence Brazilian managers can comfortably invest and use working capital independent of crises period or post-crises. That is, it is not necessary to have different financing or investment strategy between crises and post-crises periods for the firm managers in Brazil.

Financially constrained firms in Brazil have a deep financial difficulty and hardly invest at the periods of crises due to credit shortages and this impact continues in post-crises because this study confirms the indifference of investment and investment to cash flow sensitivity for financially constrained firms. Brazilian credit crises in the financial market reduce or almost eliminate investment financing due to strong "*flight to quality*" tendencies in Brazilian financial institutes which provide long-term financings for corporate investment.

Finally, it is recommendable to apply similar research on other emerging market countries reflecting each country's institutional characteristics on hypotheses, it would be interesting to investigate the differences of the results whether the other countries would demonstrate the similar or different results from this thesis.

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Appendix

Table A-1. HAUSMAN test (fixed effects, random effects, pooled)

Total sample (Fixed effect Model)					
Dependent variable	I/K				
Explnatory	Coef.	t	P>t	[95% Conf. Interval]	
Q	0.0530533	3.16	0.002	0.0201291	0.0859774
CFK	0.0329741	7.97	0	0.0248641	0.0410841
WCK	0.009583	2.18	0.029	0.0009714	0.0181945
size	-0.0456451	-1.2	0.232	-0.1204686	0.0291784
constant	0.658168	2.79	0.005	0.1962731	1.120063
No. of observation			5225		
obs. periods (years)			20 year (1998-2017)		
R^2			0.0105		
Model			Fiexed effect Model		
Hausman test fe x re			Prob>chi2 = 0.0000		
Result of Hausman Test (FE X RE)			**Fixed effect**		
Total sample (Random effect Model)					
Dependent variable	I/K				
Explnatory	Coef.	z	P>z	[95% Conf. Interval]	
Q	0.0462518	3.07	0.002	0.0167198	0.0757838
CFK	0.016129	4.91	0.000	0.0096931	0.0225648
WCK	0.014123	3.69	0.000	0.0066209	0.021625
size	0.0192033	0.82	0.413	-0.0267982	0.0652048
constant	0.3013212	2.07	0.038	0.0160304	0.5866119
No. of observation			5225		
obs. periods (years)			20 year (1998-2017)		
R^2			0.021		
Model			Random effect model		
Breusch Pagan test (random x pool)			Prob>chi2 = 0.0000		
Total sample (Pooled Model)					
Dependent variable	I/K				
Explnatory	Coef.	z	P>z	95% Conf. Interval]	
Q	0.0462054	3.63	0	0.0212532	0.0711576
CFK	0.0259975	7.99	0.000	0.0196152	0.0323799
WCK	0.0050078	1.25	0.212	-0.0028588	0.0128745
size	0.0721083	6.44	0	0.0501543	0.0940623
constant	-0.0520973	-0.73	0.468	-0.1928595	0.0886649
No. of observation			0.038		
obs. periods (years)			20 year (1998-2017)		
R^2			0.0266		
Model			Pooled model		
Breusch Pagan test (random x pool)			Prob>chi2 = 0.0000		

Table A-2 Modified test of WALD (to detect Heteroskedasticity with fixed effect)

Criteria	**TOTAL SAMPLE**	
	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (561) = 1.4e+36 Prob>chi2 = 0.0000	
Criteria	**PAYOUT / FIRM SIZE**	
Classification	*FUNC*	*FCON*
	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (122) = 3.9e+35 Prob>chi2 = 0.0000	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (261) = 2.8e+37 Prob>chi2 = 0.0000
Criteria	**CASH / LEVERAGE**	
Classification	*FUNC*	*FCON*
	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (52) = 1.4e+33 Prob>chi2 = 0.0000	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (100) = 1.0e+35 Prob>chi2 = 0.0000
Criteria	**FIRM SIZE / FIRM AGE**	
Classification	*FUNC*	*FCON*
	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (181) = 3.8e+38 Prob>chi2 = 0.0000	Modified Wald test for groupwise heteroskedasticity (Dependent varaible : IK) in fixed effect regression model H0: sigma(i)^2 = sigma^2 for all i chi2 (147) = 4.4e+36 Prob>chi2 = 0.0000

Table A-3 BREUSCH-PAGAN test (to detect Heteroskedasticity with random effect)

Criteria	**TOTAL SAMPLE**	
	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of **IK** chi2(1) = 1.40 Prob > chi2 = 0.2373	
Criteria	**PAYOUT / FIRM SIZE**	
Classification	*FUNC*	*FCON*
	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 262.90 Prob > chi2 = 0.0000	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 435.34 Prob > chi2 = 0.0000
Criteria	**CASH / LEVERAGE**	
Classification	*FUNC*	*FCON*
	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 181.76 Prob > chi2 = 0.0000	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 144.05 Prob > chi2 = 0.0000
Criteria	**FIRM SIZE / FIRM AGE**	
Classification	*FUNC*	*FCON*
	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 301.48 Prob > chi2 = 0.0000	Breusch-Pagan / Cook-Weisberg test for heteroskedasticity Ho: Constant variance Variables: fitted values of IK chi2(1) = 537.12 Prob > chi2 = 0.0000

Table A-4 Autocorrelation test

TOTAL
Wald chi2(5) = 56.58; Prob > chi2 = 0.0000
rho_ar .4340641 (estimated autocorrelation coefficient)
sigma_u .45413523
sigma_e .65688471
rho_fov .32339197 (fraction of variance due to u_i)
modified Bhargava et al. Durbin-Watson = 1.2520434
Baltagi-Wu LBI = 1.6361515

PAYOUT / FIRM SIZE	
FUNC	FCON
Wald chi2(5) = 154.36; Prob > chi2 = 0.0000	Wald chi2(5) = 90,61; Prob > chi2 = 0.0000
rho_ar .64483127 (estimated autocorrelation coefficient)	rho_ar .60774461 (estimated autocorrelation coefficient)
sigma_u .31218977	sigma_u .51716603
sigma_e .72280604	sigma_e .60889761
rho_fov .15722007 (fraction of variance due to u_i)	rho_fov .41907486 (fraction of variance due to u_i)
modified Bhargava et al. Durbin-Watson = .93269372	modified Bhargava et al. Durbin-Watson = 1.1147916
Baltagi-Wu LBI = 1.7855779	Baltagi-Wu LBI = 1.6411274
CASH / LEVERAGE	
FUNC	FCON
Wald chi2(5) = 199.84; Prob > chi2 = 0.0000	Wald chi2(5) = 99.32; Prob > chi2 = 0.0000
rho_ar .23318576 (estimated autocorrelation coefficient)	rho_ar .36588679 (estimated autocorrelation coefficient)
sigma_u .34872853	sigma_u .47517711
sigma_e .65874435	sigma_e .33261101
rho_fov .2189008 (fraction of variance due to u_i)	rho_fov .67115815 (fraction of variance due to u_i)
modified Bhargava et al. Durbin-Watson = 1.5771447	modified Bhargava et al. Durbin-Watson = 1.417485
Baltagi-Wu LBI = 1.8175638	Baltagi-Wu LBI = 2.079599
FIRM SIZE/ FIRM AGE	
FUNC	FCON
Wald chi2(5) = 165.44; Prob > chi2 = 0.0000	Wald chi2(5) = 144.19; Prob > chi2 = 0.0000
rho_ar .23660298 (estimated autocorrelation coefficient)	rho_ar .52211021 (estimated autocorrelation coefficient)
sigma_u .46738595	sigma_u .50901924
sigma_e .60825244	sigma_e .48674601
rho_fov .37124737 (fraction of variance due to u_i)	rho_fov .52235676 (fraction of variance due to u_i)
modified Bhargava et al. Durbin-Watson = 1.6329552	modified Bhargava et al. Durbin-Watson = 1.1692154
Baltagi-Wu LBI = 2.6046495	Baltagi-Wu LBI = 1.8280169

Table A-5 Endogeneity test with OLS regression (before the application of IV estimators)

Criteria	**TOTAL SAMPLE**	
	(1) CFK_res = 0 F(1, 5221) = 4.8e+05 Prob > F = 0.0000	
Criteria	**PAYOUT / FIRM SIZE**	
Classification	*FUNC*	*FCON*
	(1) CFK_res = 0 F(1, 456) = 854.97 Prob > F = 0.0000	(1) CFK_res = 0 F(1, 1322) = 2.2e+05 Prob > F = 0.0000
Criteria	**CASH / LEVERAGE**	
Classification	*FUNC*	*FCON*
	(1) CFK_res = 0 F(1, 484) = 1831.52 Prob > F = 0.0000	(1) CFK_res = 0 F(1, 446) = 4125.01 Prob > F = 0.0000
Criteria	**FIRM SIZE / FIRM AGE**	
Classification	*FUNC*	*FCON*
	(1) CFK_res = 0 F(1, 514) = 1065.20 Prob > F = 0.0000	(1) CFK_res = 0 F(1, 435) = 8478.17 Prob > F = 0.0000

In STATA/IC version 14.2, 1) regress the suspicious (endogenous) variable (for example, CFK) as dependent variable with other appropriate explanatory variables; 2) command "predict CFK_res, res" to create residual variable; 3) do another (main) regression together with newly created residual variable (CFK_res) as a control variable to align with the objective of the research; 4) command "test CFK_res" to detect (validate) the endogeneity (prob>F).

Table A-6 Endogeneity test with GMM estimations (after the IV estimations)

IV		CFK t-1, CFK t-2	CFK t-1, CFK t-2, Qt-1, Q t-2
TOTAL SAMPLE		GMM C statistic chi2(1) = 1.12844 (p = 0.2881)	GMM C statistic chi2(2) = 11.8638 (p = 0.0027)*
PAYOUT / SIZE	FUNC	GMM C statistic chi2(1) = 2.97693 (p = 0.0845)	GMM C statistic chi2(2) = 2.76421 (p = 0.2510)
	FCON	GMM C statistic chi2(1) = .012604 (p = 0.9106)	GMM C statistic chi2(2) = 8.54778 (p = 0.0139)*
CASH / LEVERAGE	FUNC	GMM C statistic chi2(1) = 0.31331 (p = 0.5757)	GMM C statistic chi2(2) = 2.19476 (p = 0.3377)
	FCON	GMM C statistic chi2(1) = .428274 (p = 0.5128)	GMM C statistic chi2(2) = 3.44599 (p = 0.1785)
SIZE / AGE	FUNC	GMM C statistic chi2(1) = 1.87803 (p = 0.1706)	GMM C statistic chi2(2) = 2.47131 (p = 0.2906)
	FCON	GMM C statistic chi2(1) = .000752 (p = 0.9781)	GMM C statistic chi2(2) = 6.68353 (p = 0.0354)*

H0: variables are exogenous (* demonstrate that instrumental variables are endogenous with p-value < 0.05).

Table A-7 Over-identification test (SARGAN-HANSEN test)

IV		CFK t-1, CFK t-2	CFK t-1, CFK t-2, Qt-1, Q t-2
TOTAL SAMPLE		Hansen's J chi2(1) = .72902 (p = 0.3932)	Hansen's J chi2(2) = 1.36867 (p = 0.5044)
PAYOUT / SIZE	FUNC	Hansen's J chi2(1) = .827331 (p = 0.3630)	Hansen's J chi2(2) = 1.15697 (p = 0.5607)
	FCON	Hansen's J chi2(1) = 1.10158 (p = 0.2939)	Hansen's J chi2(2) = 11.3571 (p = 0.0034)*
CASH / LEVERAGE	FUNC	Hansen's J chi2(1) = 1.60787 (p = 0.2048)	Hansen's J chi2(2) = 2.41709 (p = 0.2986)
	FCON	Hansen's J chi2(1) = 1.37034 (p = 0.2418)	Hansen's J chi2(2) = 5.08100 (p = 0.0788)
SIZE / AGE	FUNC	Hansen's J chi2(1) = .908952 (p = 0.3404)	Hansen's J chi2(2) = 1.84007 (p = 0.3985)
	FCON	Hansen's J chi2(1) = 2.10862 (p = 0.1465)	Hansen's J chi2(2) = 5.04294 (p = 0.0803)

H0: utilized instrumental variable is valid (* demonstrate that instrumental variables are void endogenous with p-value < 0.05).

Table A-8. Skewness/Kurtosis tests for Normality

TOTAL					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	5225	0.0000	0.0000	.	0.0000
PAYOUT / SIZE (FUNC)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	455	0.0000	0.0000	.	0.0000
PAYOUT / SIZE (FCON)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	1354	0.0000	0.0000	.	0.000
CASH / LEVERAGE (FUNC)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	488	0.0000	0.0000	.	0.0000
CASH / LEVERAGE (FCON)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	440	0.0000	0.0000	.	0.0000
SIZE / AGE (FUNC)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	547	0.0000	0.0000	.	0.0000
SIZE / AGE (FCON)					
Variable	Obs	Pr(Skewne:	Pr(Kurtosis adj	chi2(2)	Prob>chi2
myresidual	469	0.0000	0.0000	.	0.0000