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Does equity volatility affect the corporate investment level?

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Abstract

The paper studies the relation between valuation and corporate investment level. It provides an insight to the q-model and its implications for investment level. By acknowledge the q-model's empirical shortcomings it questions whether adjustments for volatility will strengthen the q-model empirically. It argues: as volatility is a proxy for risk, stock market volatility would be related to firm behaviour and investment decisions.

1 Introduction

The relationship between corporate value and the level of investment has been quite mysterious in investment researches despite the implications of a strong relationship between investment and the stock market valuation. The question is: since stock market valuation is volatile will adjustments for volatility strengthen the empirical relation between corporate investment level and stock market valuation? Surprisingly, there are a very few papers that have attempted to explore the effect of excess volatility measures in investment levels.

The *q*-model offers theoretical understanding of the relationship between valuation and corporate investment level (Tobin, 1969). However, empirical results suggest that corporations rely more on internal funds (cash flow) than external funds (debt and equity) (see e.g. Fazzari, Hubbard and Petersen, 1988). We bring in arguments how stock market volatility is relevant when trying to explain investment levels with the q-model.

The aim of this paper is to bring clarity to the impact that excess volatility has on investment level of Swedish corporations. The implications of the equity volatility for the corporate sector of the Swedish economy such as its likely impact on firms' investment decisions are explored. Based on the hypothesis that volatility and its changes are negatively related to investment growth, we examine the empirical relation between equity volatility and corporate investment in 190 large Swedish corporations between 1985 and 2000.

Based on earlier empirical studies on capital market imperfection and stock market fluctuations, we introduce volatility to the q model besides other financial factors, such as cash flow and leverage that we suspect might influence investment levels. We run OLS regression to test our hypothesis and also to see the significance the chosen variables have to investment levels. Since we have panel data we also estimate fixed effect regressions on the models in order to adjust for firm heterogeneity.

We conclude by discussing the implications of our findings. We argue that stock market volatility appears to be related to firm behaviour as volatility is a proxy for risk. However, although volatility appears to be associated with less investment it does not improve the significance of q itself. Moreover, it is especially firms with low q, i.e. close to one, that invest less when volatility increases. Finally volatility does not appear to affect the investment cash flow sensitivity.

This paper is organized as follows. Section 2 reviews the theoretical arguments behind investment level and corporate value. Section 3 presents early empirical results. Section 4 discusses the development of the research hypothesis. Section 5 entails the method used. Section 6 displays our empirical results. Section 7 preserves discussion and draws conclusion.

2 Theory

In the last few decades, quite a significant literary attention has been given to corporate value and level of investment (Jorgenson, 1963; Hayashi, 1982; Fazzari, Hubbard, Petersen, 1988; Bond and Meghir, 1994; Kaplan and Zingales, 1997) where a number of structural investment models have been proposed. These models have generally been adapted to tests for financial constraints – the best-known is the Q-model. For example, the concept of the user cost of capital was developed by Jorgensson (1963), which is the minimum rate of return an investment project must earn before the firm is considered to be attractive. The minimum rate depends on rates of interest, inflation and depreciation, as well as taxes (see Bond, Denny and Devereux (1993)).

In the following sections we study the Q-model and its implication for investment level, what it means to be financially constrained and also the concept of optimality given financial constraints, i.e., additional costs that asymmetric information and taxation etc, entail.

2.1 The Q-model

Tobin's theory (1963) proposes that investment is a positive function of a variable q, which is defined as the market value of the firm divided by its replacement cost. The

model is based on the capital adjustment costs that are internal to the firm. According to Tobin's q theory, capital investment depends on the ratio of the market's valuation of capital to the cost of acquiring new capital (see Fazzari, Hubbard and Petersen, 1988). The ratio can be perceived as an indicator to the investor how attractive a firm is. In general, it is assumed that firms will try to attract investors until an equilibrium state is attained in the capital market i.e. when q=1. Thence, if a firm has a q-ratio above 1 it has an incentive to invest that is greater than a firm with a q-ratio below 1. Firms with high q-ratios have the propensity to be those firms with attractive investment opportunities or a significant competitive advantage.

The q-model develops the idea that firms face (strictly convex) cost of adjustment when changing the level of the capital stock. The basic intuition is that an investment project that adds more to the firm's market value than it costs to carry out will be profitable. Profitable opportunities will be higher when the firm's actual capital stock is below its optimal capital stock (Bond and Meghir, 1994). For this reason, investment is expected to be higher when the market valuation of the firm's capital is high relative to its replacement costs. We have to note here that a fundamental issue in performance measure choice is influenced by fundamental differences between finance and economics. Value and profitability are often used interchangeably as performance standards even though they each represent a different phenomenon (for a discussion, see Stevens, 1990) which results in slightly different conclusions. Thus, finance maintains the q-ratio for the anticipated changes in financial market valuation of all rents to the firm including both the level and risk of future profitability.

The appeal of the q-ratio as a performance indicator over other models such as the accounting rate of return is that it provides a better approximation to its "true" measure – i.e. "correct" market value. Stevens (1990) found that q has a much higher average correlation with it is true measure. Furthermore, McFarland (1988), who used Monte Carlo experiments to determine which accounting measure provides the best approximation, found that q estimates have smaller errors than most accounting rate of return measures.

Even though the q-model assumes that investment decisions are dependent on expectations of future profitability, the theory implies that there should be a simple

relationship between current rate of investment and q-ratio. In principle, the market value of the firm's capital stock can be estimated by combining the stock market value of the company with estimates of the market value of the firm's debt liabilities and other assets. Expectations of future profitability are therefore "measured" in this model by the stock market valuation. Hence under these stringent conditions, the q-variable summarises all expectations that are relevant for investment behaviour (Bond and Meghir, 1982). These requirements include perfect competition, constant returns to scale and, crucially, that the stock-market value correctly measures the "fundamental" expected present value of the firm's net cash flows.

The benefit here is that if these conditions are fulfilled then the effect of cash-flow or profitability variables on expectations of future demand or costs should already be captured by the q-ratio. If it is the case that such financial variables are significant determinants of investment in addition to the measure of q. Then we can deduce that these terms are really picking up the influence of financial constraints (see Bond and Meghir 1994).

The problem is that we can never be sure if these conditions are met in practice (for one, we do not have full data of the firms situation let alone its future plans). It is often put forward, for instance, that stock market prices are "noisy" or that they display excessive volatility relative to the fundamental value of firms (see Shiller, 1981). If this is the case then measures of q would be subject to error, and current financial variables such as cash flow may provide additional information about the true value of this ratio (Bond and Meghir, 1994). In this case we are back to the problem of disentangling expectational effects from the effects of financial constraints.

2.2 Financing Constraints

To finance its investment, a firm can either rely on retained earnings (internal financing) or, acquire external financing. External financing comes in many different forms, as equity through new shares, as a new debt, or as mix of the two. Modigliani and Miller (1963) purposed that a firm's financial structure is irrelevant if there are no taxes and capital markets are perfect. If firms have equal access to capital markets (an indication of

perfect capital markets) we would expect their response to changes in the costs of capital or tax-based investment incentives to differ only when they have differences in investment demand (Fazzari, Hubbard and Petersen, 1988). In other words, external finances would be perceived as a perfect substitute for internal finance. However, since capital market imperfections do exist, they impose financing constraints. The most precise, but also broadest, definition classifies firms as financially constrained if they face a wedge between the internal and external costs of funds (Kaplan and Zingales, 1997). According to this definition, all firms are likely to be classified as financially constrained, as a small transaction cost of raising external funds would be enough to put a firm into this class.

Fazzari, Hubbard and Petersen (1988) also address the issue of imperfect markets in terms of external finance not being a perfect substitute to internal finance. They illustrate the implications of "asymmetric information" in relation to investment and to the disparities in the access of individual firms to capital markets. They argue that the notion that financial structure's irrelevance to the investment decision may not even apply to mature companies. This is because asymmetric information makes it costly, almost even impossible, for providers of external finance to evaluate the quality of firms' investment opportunities. Consequently, the cost of new debt and equity may differ considerably from the opportunity cost of internal finance generated through cash flow and retained earning.

2.2.1 Internal or External financing?

To give an insight to firms' choice of financial funds for their investment we have to discuss the implications that their choices entail. We have stated above that since markets are imperfect, internal finance is not a perfect substitute to external finance. But what does it mean really? This is because internal finance may be less costly (both directly and indirectly) than the cost associated with new shares issues and debt finance. The reasons are transaction costs, agency costs, costs of financial distress, tax disadvantages and asymmetric information.

For example, the costs of new shares issues include underwriting discounts, registration fees and taxes, selling and administrative expenses, which vary substantially by size of offering. For relatively smaller offerings the costs can be quite high because of transaction

costs - this can have quite an impact especially for smaller firms. In addition to this both direct and indirect cost of offerings are higher for initial public offering than for seasoned offerings.

Furthermore, while no tax savings accrue from the issue of new shares, tax savings do arise when earnings are retained rather than paid out. This is because a dividend tax is replaced with a potentially lower tax on capital gains. Thence, the differential gives a cost advantage to internal finance (see Fazzari, Hubbard and Petersen, 1988).

On the other hand, debt finance and the effects of leverage on the firm's cost of funds posit an increasing marginal cost of new debt due to costs of financial distress and agency costs (Fazzari, Hubbard and Petersen, 1988). Financial distress costs arise when a firm has difficulties meeting its principal and interest obligations – the extreme case being bankruptcy. As firms have an inclination of preferring debt to equity (debt financing is seen to be more advantageous than equity because it reduces the expected tax liability and increases after tax cash flow), the long term debt often poses a risk for agency costs. This is because of fluctuations in long-term interest rates which increase agency costs. Agency costs arise from the limited liability feature of debt contracts that creates incentives for firm managers not to act in the interest of creditors, under some circumstances. While it is generally true that higher leverage entails a higher shadow price of funds, only the largest and most mature firms are likely to face a smoothly increasing loan interest rate. This is, for example, smaller firms are usually overlooked by lenders for better-quality borrowers for fear that they might default (Fazzari, Hubbard and Petersen, 1988). The benefits and costs of debt financing affect the financial behaviour of firms as the effects of taxation and capital market imperfections on financial policy also spills over to the capital formation process through the cost of capital (Jansson, 2002).

2.3 Wedge Between Cost of Internal and External Funds and "Pecking Order Theory"

By definition, when external costs of funds are not a perfect substitute for internal costs of funds then there is a wedge between external and internal funds. We can employ this definition as a useful framework to differentiate firms according to the extent to which they are financially constrained. A firm is classified as more financially constrained as the wedge between its internal and external cost of funds increases (Kaplan and Zingales,

1997). In general, the less constrained firms are said to be those firms with relatively large amount of liquid and net worth.

An imperative question is whether the wedge between the cost of internal and external funds is due to transaction costs associated with placing new share issues (Myers, 1984) and/or the asymmetric information problems (agency problems) Myers and Majluf, 1984).

The argument that external financing transactions costs, especially those associated with the problem of adverse selection, create a dynamic environment in which firms have a preference, or pecking-order of preferred sources of financing, when all else is equal. Myers (1984) "pecking order theory" captures that the capital structure is designed to limit inefficiencies caused by informational asymmetries and therefore constrains investment spending because of shortages of internal funds. Here, it is assumed that the manager knows more about the value of existing assets and growth opportunities than the investor does. Under this assumption, a potential adverse selection problem arises as firms with lower value opportunities have an incentive to issue securities that imitate firms with higher growth opportunities. Hence, shares of the former firms are overvalued while those of the latter firms are undervalued.

To avoid loss of wealth, only share-holders with overvalued assets in place will rely on outside financing and investors will interpret a decision not to issue shares to signal good news. This leads to a pooling market equilibrium in which new shares are offered at a marked-down price. The adverse selection problem can be improved if capital structure follows a particular hierarchy, which prefers the method of financing that is less risky and less sensitive to valuation errors. Therefore, internally generated funds with no risks are preferred to external financing, whilst debt with prior claim and lower risks is preferred to equity. This is what we call "financing hierarchy". For the benefits of debt, capital structure is used as a signal of private insider information under the framework of asymmetric information (Fazzari, Hubbard and Petersen 1988).

Because information asymmetries place additional fixed costs on external financing, firms prefer internal financing to external financing. The pecking order theory implies that fluctuations in internal funds should predict the timing of when external financing is acquired. It also suggests that the observed mix of debt and equity should be a cumulative

result of hierarchical financing decisions overtime. Myers(1984) emphasises that the debt level of a firm equals the cumulative need for external funds and, therefore, firms do not have an optimal capital structure but strive to get there. To avoid miss-valuations, firms use up all retained earnings to fund new projects. When internal finance is insufficient, debt will be preferred to outside equity financing, with the latter only being used as the last resort when debt capacity is exceeded.

On the other hand, the pecking order theory can be compared to the trade-off theory which suggests that benefits of additional debt financing such as the tax deduction of interest payments, are traded against the cost of additional debt. For example, increased expected bankruptcy costs and that firm have an optimal capital structure. Nevertheless, it is not necessarily the case that the optimal and actual leverage coincide, because of the presence of random events and costs for adjusting the capital structure (Jonsson, 2002).

Auerbach (1984) models for firms' behaviour in a tax based model that is consistent with the maximization of shareholder wealth. The results indicate that new shares are conceived by firms as a more expensive means of finance than retention. This is because the differential taxation of capital gains and dividends at the personal level which contribute to the differences in the costs of internal and external finance. Auerbach argues that new shares are not issued at the exact time dividends are paid. Therefore firms can not finance new investments out of retained earnings whenever possible. This suggests that firm's facing various financial constraints must, at least in the short tem, behave in a manner that is not optimal in the long term i.e. issuing new shares, instead of cutting dividends when they have already too much debt.

3 Earlier Empirical Results

An interesting question is if internal financing is preferred to external financing in investment spending empirically. And if so, what are the determinants of internal finances for the firm? Earlier studies have attempted to define the financial factors associated with internal financing. We have noted earlier that the q-model has not been very successful in explaining corporate investment level empirically. Nonetheless, one argument that has

been quite interesting (and become central) is the correlation of cash flows to investment spending. This result suggests that cash flow may provide information about the true value of this ratio, hence associating cash-flow to investment growth. Empirical findings have differed in how much corporate investment relied on cash flow sensitivities.

Thirty years ago, the view that firms financing decisions were not affected by the financial factors was widespread. Thence, the availability of internal finance did not matter for investment. At the time, most of the empirical evidence did not seem to contradict this view. Jorgenson (1971) noted that "variables associated with internal finance do not appear as significant determinants of desired capital in any model that includes output as a significant determinant". But already then there was a trace of recognition of the correlation between investment spending and cash flow. Coen (1971) allowed the speed with which investment respond to changes in desired capital to depend on cash flow. He found that a significantly faster response when cash flow was high. Since then there was a rising interest to this topic breaking down this view (as we have seen above in the pecking order theory). How much impact does cash flow has on investment spending? Some believe that if investments are cash flow sensitive then the firms face financial constraints. Others disagree.

Fazzari, Hubbar, and Petersson (1988) argue that investment -cash flow sensitivities provide a useful measure of financing constraints. They used manufacturing firm data which they classed according to their earning retention practices. Their results indicated a significantly greater sensitivity of investment-cash flow and liquidity in firms that retain all of their income.

Kaplan and Zingales (KZ) (1997) using the same sample data as Fazzari, Hubbard and Petersen (FHP) (1988) came to a different conclusion in pursuing the question whether "investment cash flow sensitivities provided a useful measure of financing constraints?". They argue that despite the fact that constrained firms are sensitive to cash flow while unconstrained are not, it is not necessarily true that the magnitude of the sensitivity increases in the degree of financing constraints. Their result illustrates that a high sensitivity of investment to cash flow is not associated with financially constrained firms. Contrary to FHP results, KZ found that the correlation between investment-cash flow sensitivities and the degree of financing constraints are negative rather than positive as

FHP found. Furthermore, they emphasise that the sensitivity between investment-cash flow and financing constraints are not monotonic, at least monotonicity is not to be taken for granted.

Despite their different conclusion, FHP and KZ's use the same data, i.e. from the same sample periods. However, their approaches differ in several respects. For example, to overcome the deficiencies that grounded in the neoclassical q accelerator, FHP lagged the cash-flows variable in when they estimated the q investment equation. KZ, on the other hand, use Euler's equation test which does not rely on Tobin's q. Although it is not the interest of this paper to compare the findings of these papers, it is necessary to point out how much approach and source can make a difference (for further comparison, see Fazarri, Hubbard and Petersen, 1988 and Kaplan and Zingales, 1997)

One paper that contemplated on the choice of the approach is Bond and Meghir (1994). Bond and Meghir (1994) favour the Euler equation over the q-model for testing the importance of financial constraints on investment. They find that investment spending by large corporations is likely to be affected by the availability of internal finance. Thence, they conclude that financial constraints on investment are an unavoidable consequence of asymmetric information between investors and firms which can be reduced by purposed policy measures.

4 Development of Research Hypothesis

Since investment decisions are likely to depend not only on the current level of the optimal stock, but also on the levels of the capital stock that the firm expects will be optimal in the future – its future expected returns are based on forecasting. As we noted above, the assumption that the q variable "captures all expectations that are relevant for investment behaviour" (which implies a strong relationship between the stock market value and investment), can not be taken for granted since it does not explain the "noisy" behaviour that is associated with stock market prices (Bond and Meghir,1994). Can the introduction of excess volatility to the models developed so far provide part of the explanation to the relationship between investment and internal cash flow?

4.1 Excess Volatility

In his paper "Do Stock Prices Move Too Much to be Justified by Subsequent Changes in Dividends", Shiller (1981) illustrates the impact the price index movements assert on dividends. In this paper, Shiller investigates what accounts for movements in real stock prices and whether they can be explained by new information about subsequent real dividends. He defines the real stock prices as "the present value of rationally expected or optimally forecasted future real dividends discounted by a constant real discount rate". New information is attributed about future dividends when this value of expectations changes. His explanation of the limit on stock price volatility allows us to see how important information is and specially when revealing information about future dividends. This is since the markets do not predetermine with certainty the growth path and distribution of dividends that is ultimately observed. It is hard for one to be sure that they were wrong to consider major events which is going to occur or might not occur.

A fundamental principle of optimal forecasting is that the forecast error must be uncorrelated to with the forecast. In this case, Shiller claims that the excess volatility of stock price index (the tendency of big movements to occur too frequently) implies that stock market crashes are not rational mistakes but rather inefficient markets, which is captured by the "noise".

Shiller develops tests of market efficiency that focus on stock prices variance. These variance-bound tests compare the variance of actual stock price to an upper bound, the variance of a function of actual dividends. Shiller argues that the error in forecasts is uncorrelated with the optimal forecast; hence the variance of the non-optimal forecast must be greater than the variance in the optimal forecast. Under the efficient market hypothesis actual stock price is the conditional mathematical expectation of *ex post* rational price. Shiller tests this inequality of variance in actual stock price and the *ex post* rational stock price using two data sets containing annual observations of a deflated stock price index and the associated dividends. His results indicate that the stock prices are too volatile to be determined by the present discounted rate of dividends.

The relationship between the expected rate of investment and q-ratio could have been rather simple if the q-ratio captured all expectations that are relevant for investment

behaviour. However, as argued by Shiller, stock market prices are too "noisy" and therefore they display excessive volatility relative to the fundamental value of the firm. Consequently, since the q-ratio does not capture all expectations it is subject to error.

4.2 Hypothesis

Some empirical papers have found evidence that has rebuffed the q-model as inadequate in explaining investment behaviour. Other papers have documented excess volatility in the stock market. Therefore, we would like to bring excess volatility to the q-model and see if we can shed further light on the link between corporate value and investment levels. Despite the shortcoming of the q-model's we believe the excess volatility can provide some elucidation to the model when dealing with investment growth. Hence our hypothesis:

Volatility and its changes are negatively related to investment growth.

This is related to Hu's (1995) suggestions for several possible channels for stock market volatility to affect the investment decisions of firms. If the stock market price is "too volatile" and substantially deviates from fundamentals, investors may be less willing to hold equities, hence a tendency to raise the cost of capital and depress investment. Second, if the stock market undervalues a firm's capital, the firm's dominant strategy will be to buy existing plant and equipment instead of installing new capital as an attempt to reduce risk. Here there will be a lot of mergers and acquisitions taking place, but little new investment. Third, high volatility may reduce the role of the stock market as a forecasting mechanism. In addition to this it may encourage firms to systematically ignore volatile short-run changes in stock prices in making long-term investment decisions. Hence the stock market turns into only a sideshow for the real economy. Moreover, because investments are usually irreversible, stock market volatility may affect investment through its effect on timing.

5 Method

In this paper we link conventional models of investment to more recent literature on capital market imperfections and fluctuations in the stock markets. We introduce excess volatility to the q-measure in the anticipation that it will provide additional information about the true value of the ratio that other financial variables like cash flow could not capture. Furthermore we study the interaction variable of q and excess volatility. We also take the effects of leverage into consideration. The goal here is to see if we can identify other variables that contribute to q not capturing all the expectations that are relevant for investment behaviour. We run OLS and fixed effect regressions to test our hypothesis.

5.1 Sample

In this paper we analyze the sample of 190 large Swedish corporations. We have obtained data from Findata for the sample period 1985 and 2000. We chose these firms to see if cash flow sensitivity applies even to large corporation (Fazzari, Hubbard and Petersen, 1988). Secondly, since all these firms are listed in the stock market their investment decisions could be influenced by stock market changes.

5.2 Variable Definitions

We measure investment as the capital expenditure, (I_t). Cash flow equals the sum of earnings before extraordinary items and depreciation, (CF_t). We deflate both investment and cash flow by beginning of year capital (K_{t-1}) which we define as total assets. (Q) equals the market value of assets divided by the book value of assets. Leverage is defined as the long term debt divided by total assets $(Leverage_{t-1})$ from the beginning of the year. Excess volatility is the relative average yearly rate at which stock prices move up or down, $(Volatility_t)$. The interaction variable is the product of q and volatility $(Qvolatility)$.

5.3 Empirical Models

In this section we present the estimated empirical models. We use different estimation techniques and specifications. There are a number of problems, as we have argued above that might affect measures of q and the econometric results. For one, due to excessive volatility q might not reflect market fundamentals. And also that replacement capital stock in q may be measured with error. We use the average value of q ($\overline{Q}$) which is defined as q at the beginning of the year plus q at the end of the year divided by two The basic model is the same as the one estimated by e.g. FHP and KZ.

$$I_t / K_{t-1} = \overline{Q} + CF_t / K_{t-1} + Year\ Dummies$$

We then add leverage to capture the effect of potential financial constraints (Hadlock, 1998). Finally, volatility and interaction term with the average q is included in the model. The interaction term is included in order to capture the effects of high q with volatility implying weaker relation between volatility and investment if the firm has a high q. This is the effect does not make a difference with q values above 1.

We first present the results from OLS regressions. However, since we have multiple observations on the same firm observations are not independent and the assumptions of OLS are violated. We therefore also estimate fixed effect panel data regressions which controls for unobserved firm heterogeneity.

$$I_t / K_{t-1} = \overline{Q} + CF_t / K_{t-1} + Year\ Dummies + Firm\ Dummies$$

The fixed year effects are included in order to capture aggregate business-cycles influences. Fixed firm effects account for unobserved time-invariant effect on investment. This is within the effects of q or the financial variables on investment are captured by our estimates.

5.4 Descriptive Statistics

The firms in our sample data are typically large, and their stock is publicly traded. Summary statistics for the firms in our sample are presented in table 1. One important observation, based on the mean values, is that Swedish firms have investment level of 15% per year. In mean terms, 12% of these firms' cash flow is used to finance investment

whereas 26% relies on external funds like debt – hence implying that they are levered. The data seems to be influenced by outliers, especially in q and volatility. By checking for errors in the data, we found that volatility had extreme values which we adjusted by dropping values below 0.1 and above 2. Once we have done this we found that the extreme values in q were relevant. This is when we run for the lagged values of q results were found to be roughly the same in unreported regressions (see the last two rows q and lagged q).

Table 1 Summary Statistics: ***Investment, cash flow, q, volatility and leverage***

Investment is measured as the capital expenditure over book of total assets, (I_t / K_{t-1}). *Cash flow equals the sum of earnings before extraordinary items and depreciation over book value of total assets* (CF_t / K_{t-1}). (Q) *equals the market value of assets divided by the book value of assets. Leverage is defined as the long term debt divided by total assets* $(Leverage_{t-1})$ *from the beginning of the year.* $(Volatility_t)$ *is the relative yearly rate at which stock prices move up or down,. The interaction variable is the product of q and volatility* $(Qvolatility)$ *i.e. with measures high values of q with high values of volatility. We start the q-model and develop the model by including the variables one after the other.*

All reported figures are calculated over the complete set of firm-years from 1985 to 2000.

I_t / K_{t-1}	0.152	0.089	0.217	0.000	2.129
CF_t / K_{t-1}	0.118	0.111	0.131	-1.376	1.267
$\overline{Q}$	1.554	1.181	1.326	0.573	17.717
$leverage_{t-1}$	0.260	0.232	0.172	0.000	0.979
$\sigma_t \cdot \overline{Q}$	0.716	0.440	1.037	0.013	17.952
σ_t [a]	0.419	0.355	0.259	0.100	1.977

[a] Outliers: Extreme volatility were deleted. i.e. $\sigma<0.1$ and $\sigma>2$.

Another important aspect that this table brings out is the choice of q. We show the difference between q, lagged values of q and average values of q (i.e. the average of q and lagged q). Since taking the average of q reduces the impact of extreme valuation we prefer to use the average.

6 Empirical Results

OLS results without year dummies are presented in table 2.

Table 2 OLS regressions

Regression for190 large Swedish corporations between1985 and 2000. Dependent variable is Investment and the independent variables are average q, cash-flow, lagged leverage, volatility and interaction variables. Investment is measured as the capital expenditure over book of total assets, (I_t / K_{t-1}). *Cash flow equals the sum of earnings before extraordinary items and depreciation over book value of total assets* (CF_t / K_{t-1}). (Q) *equals the market value of assets divided by the book value of assets. Leverage is defined as the long term debt divided by total assets* $(Leverage_{t-1})$ *from the beginning of the year.* $(Volatility_t)$ *is the relative yearly rate at which stock prices move up or down,. The interaction variable is the product of q and volatility* $(Qvolatility)$ *i.e. with measures high values of Q with high values of volatility. We start the q-model and develop the model by including the variables one after the other.*

All models are corrected for heteroscedasticity according to white (1980).

****, **, * denote significance at the 1%, 5% and the 10% respectively.*

$\overline{Q}$	0.020	0.013	0.016	0.016	-0.009
	[2.87]***	[1.47]	[1.79]*	[1.76]*	[-0.52]
CF_t / K_{t-1}		0.284	0.298	0.296	0.322
		[2.59]**	[2.62]***	[2.54]**	[2.66]***
$Leverage_{t-1}$		.	0.087	0.087	0.089
			[1.89]*	[1.87]*	[1.91]*
$Volatility_t$				0.002	-0.043
				[1.18]*	[-1.72]*
$\overline{Q} \cdot Volatility_t$					0.041
					[1.74]*
Year dummies	Yes	No	Yes	Yes	Yes
R^2	0.015	0.043	0.047	0.046	0.050
No. Obs.	1536	1536	1532	1518	1518

When we include only average q in M1 it is positive and significant at the 1% level. However, when cash flow is included in M2 q becomes insignificant. This is roughly in line with the earlier research that has found that cash flow is a better predictor of investment than q. When leverage is included in M3 q becomes significant at the 10% level. Leverage per se is positively significant at the 10% level. This result is surprising. If leverage would be a proxy for financial constraints it should have been negative. In M4 volatility is included. The volatility coefficient is positive and statistically significant at the 10% level but economically small at 0.002. This is actually the reverse to our hypothesis that volatility should be negatively related to investment. Finally, in M5 we include the interaction term between volatility and q. Q per se is then significant while volatility per se becomes negatively significant at 10% level. The interaction term is positively significant at the 10% level suggesting that the negative relation between investment and volatility decreases at higher q levels. This is intuitive as a high volatility should be more relevant for low q firms, i.e. q close to one. If the firm has a q value substantially larger than one, volatility should not necessarily be related to investment.

In table 3 we re-estimate M5 with year dummies (See M1 in table 3). The result is essentially unchanged. The interaction term becomes significant at the 5% level, compared to at the 10% level without year dummies in table 2. Some of the year dummies are significant in table 3. These were the 1991, 1993, 1999 and 2000 dummies.

Table 3 OLS regresion with year dummies

Regression for190 large Swedish corporations between1985 and 2000.

Dependent variable is Investment and the independent variables are average q, cash-flow, lagged leverage, volatility and interaction variables. Investment is measured as the capital expenditure over book of total assets, (I_t / K_{t-1}). *Cash flow equals the sum of earnings before extraordinary items and depreciation over book value of total assets* (CF_t / K_{t-1}). (Q) *equals the market value of assets divided by the book value of assets. Leverage is defined as the long term debt divided by total assets* $(Leverage_{t-1})$ *from the beginning of the year.* $(Volatility_t)$ *is the relative yearly rate at which stock prices move up or down,. The interaction variable is the product of q and volatility* $(Qvolatility)$ *i.e. with measures high values of Q with high values of volatility.*

Dummy years are introduced in to the OLS model introduced in table 2 as M5. Regression is for all sample years. Then the sample is subdivided into 1985-1992 and 1993-2000.

All models are corrected for heteroscedasticity according to white (1980).

****, **, * denote significance at the 1%, 5% and the 10% respectively*.

$\overline{Q}$	-0.015 [-0.89]	-0.010 [-0.60]	-0.014 [-0.81]
CF_t / K_{t-1}	0.298 [2.39]**	0.309 [2.51]**	0.316 [2.57]**
$Leverage_{t-1}$	0.087 [1.85]*	0.883 [1.88]*	0.089 [1.87]*
$Volatility_t$	-0.047 [-1.87]*	-0.041 [-1.16]	-0.050 [-1.97]**
$\overline{Q} \cdot Volatility_t$	0.049 [2.11]**	0.041 [1.75]*	0.048 [2.05]**
Year dummies	Yes: All years are insignificant except ´91, ´93, ´99 and ´00.	Yes: All years are insignificant except ´88 ´89 and ´91	Yes: All years are insignificant except ´93, ´99 and ´00.
R^2	0.073	0.057	0.065
No. Obs.	1518	1518	1518

In the other two columns of table 2 we divide the sample into two sup-periods in order to investigate whether the relations have changed over time. The results are essentially the same in both sub-periods. However, when we subdivide the periods into two, volatility is insignificant in the 1985-1992 period but significant at the 5% level 1993-2000.

In table 4 we report the fixed effect models. The results are similar to the OLS results. Q is insignificant and cash flow is highly significant and positive. However, compared to the OLS models, leverage is negatively significant in the fixed effect models. This difference suggests that unobserved firm heterogeneity is correlated with both investment and leverage. A negative sign on leverage is also in line with our expectations should leverage proxy financial constraints. Volatility is negatively significant at the 5% level once the volatility q interaction term is included in M3. The interaction term is again positively significant at the 5% level suggesting that the negative relation between volatility and investment is weaker at high q levels.

Table 4 Fixed Effect Regressions

Regression for190 large Swedish corporations between1985 and 2000.

Dependent variable is Investment and the independent variables are average q, cash-flow, lagged leverage, volatility and interaction variables. Investment is measured as the capital expenditure over book of total assets, (I_t / K_{t-1}). *Cash flow equals the sum of earnings before extraordinary items and depreciation over book value of total assets* (CF_t / K_{t-1}). (Q) *equals the market value of assets divided by the book value of assets. Leverage is defined as the long term debt divided by total assets* $(Leverage_{t-1})$ *from the beginning of the year.* $(Volatility_t)$ *is the relative yearly rate at which stock prices move up or down,. The interaction variable is the product of q and volatility* $(Qvolatility)$ *i.e. with measures high values of Q with high values of volatility. We start the q-model and develop the model by including the variables one after the other.*

We use dummy years and firm dummies for the models introduced in table 1 as M3, M4 and M5.
All models are corrected for heteroscedasticity according to white (1980).
****, **, * denote significance at the 1%, 5% and the 10% respectively.*

$\overline{Q}$	0.018 [1.57]	0.018 [1.56]	-0.020 [-0.99]
CF_t / K_{t-1}	0.497 [3.13]***	0.494 [3.07]***	0.529 [3.23]***
$Leverage_{t-1}$	-0.127 [-1.64]	-0.128 [-1.65]*	-0.131 [-1.71]*
$Volatility_t$		-0.010 [-0.73]	-0.075 [-2.28]**
$\overline{Q} \cdot Volatility_t$			0.058 [2.05]**
Year dummies	Yes: All years are insignificant except ´91, ´93, ´98, ´99 and ´00.	Yes: All years are insignificant except ´91,´93,´95, ´98, ´99 and ´00	Yes: All years are insignificant except ´91-´93, ´95, ´98-´00.
R^2	0.047	0.045	0.049
No. Obs.	1532	1518	1518

These finding entail a number of important observations both for the influence of financial factors on corporate investment levels and importance of firm heterogeneity. When we used OLS models we found that investment was represented better when cash flow was introduced. Furthermore, our expectation in terms of the influence of leverage and volatility on investments were not corroborated. When we later employed the firm fixed effect regression, in order to adjust for firm heterogeneity, we observed that not only was cash flow positively significant but leverage was negatively significant as well. This is in line with our expectations of financing constraints. The significance of volatility improved in the firm fixed effect regressions, especially when we introduced the interaction variable which suggests that the negative relation between volatility and investment is weaker at high q levels. Here volatility was also in line with our expectation, i.e. it was negative and significantly related to investment levels.

7 Discussion and Conclusion

Our findings are not only consistent with the hierarchy of finance approach but also do contribute to a new perspective. It suggests that the investment spending of large Swedish corporations is affected by the availability of internal finance. Cash flow is a significant financial variable along side with long term debt and volatility. Measures of stock market volatility appear to be related to firm behaviour. In fact we have seen measure of stock market volatility having significant impact on investment level through investment decisions as volatility is a proxy for risk. Although volatility appears to not affect the investment-cash flow sensitivity it does reduce the importance of q. Thus, volatility does not improve q as we have anticipated. However, volatility per se has some implications on investment which should be addressed and not ignored.

An important topic which is not quite explored on in this paper is the effect of causality. For example excess volatility has a causal effect on investment through the firm's investment decisions, whereas investment itself might have reverse causal effect on q. To some extent the size of this effect can be discussed and might even be point a good future research angle for this paper

A suggestion for future research would be to include other financial variable such as sales or/and costs of raising external finance to see if they can offer an improvement to the q-model along side the volatility. I would also like to include longer sample period, to see if the period that we had was not exaggerated by the financial crises. Were the financing constraints for large Swedish firms only limited to the financial instability in Sweden during our sample period, or is this true for any time period? I would like to excavate deeper by studying their annual reports, (if possible management reports and discussion) and public news to give us as enhanced picture as possible of the availability of internal and external funds for each firms demand for fund and how the stock market volatility affects that. Another approach would be to carry out a comparison the role of corporate value and investment levels in Sweden and other European countries, to see how Swedish corporations are doing relative to their neighbouring corporations.

Appendix: Brief History - Sweden 1985-2000

In terms of the expansive economic politics in the 1980s and 1990s, the sample period 1985-2000 bears an interesting economic history for the Swedish economy. Already after the OPEC crises, the krona was devaluated twice in 1981 and 1982 which temporarily boomed the economy but later turned to bust in the 1990s (Jonung and Hagberg, 2005). Nonetheless the early 1980s Sweden has experienced a rapid growth in corporate sector and corporate activities picked up as their market values did. One major contributor to this was the deregulation of the credit market in 1985 that led to a rapid increase in the demand for and supply of credit. This gave rise to very low interest rates which was exaggerated by high inflation rates and inflationary expectations combined with the design of new tax system. The result was rapid growth of the financial sector and increasing asset prices. Banks grew particularly strong as mergers raised banks' competitiveness. (Jonung and Stymme, 1997)

The turn of the decade was not good news for most Swedish corporations. In 1990, the introduction of a tax reform combined with higher international interest rates and falling inflation created a sharp and sudden increase in the real rate of interest. This burst the bubble and set off a process of balance sheet adjustment with strong signs of debt deflation. Meanwhile the banking sector faced increased losses as the number of defaults increased. The whole financial sector was put under severe stress and Swedish economy was soon plagued by a "banking crisis" as well as "a currency crisis" at the same time. The depression led to a sharp increase in the cost of capital. Government expenditures increased while tax revenues stagnated leading to huge budget deficits. The Riksbank was eventually forced to let the krona float in November1992. As a result of the consequent depreciation and lowering of interest rates, an export-led recovery slowly took hold. The krona fall which made the Swedish companies relatively cheaper and increased the export level tremendously.

Under the second half of the 1990s international interest rates fell which gave a positive thrust to the stock market and the Swedish stock market followed quite strongly (Fakta om Sverige, 2000). This decline in interest rates and increased internationalism had two important impacts for the Swedish corporations. First, Swedish exports rose quite quickly

internationally, especially to the Southeast Asia which more than doubled until the Asian crises in 1997. Second, because many companies had cash flow problems as there was large credit loss among the Swedish bank and finance companies in 1991-1993 many thought that it was more beneficial to invest abroad (Wramsby och Österlun, 1995). Also merging was seen as an alternative cost effective method which resulted into many international fusions during the sample period. For example, Nordbanken and Merita in 1998 also Astra and Zeneca in 1999.

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