REVISTING THE AFFECT OF MARKET MISPRICING ON CORPORATE INVESTMENT: A DECOMPOSITION OF Q

Chau Minh Duong

Faculty of Business and Management, Canterbury Christ Church University

c.m.duong41@canterbury.ac.uk

Abstract: This paper decomposes Tobin's Q into firm-specific mispricing, industry-level mispricing, growth opportunities and financial leverage components and investigates the incremental effects of market mispricing on corporate investments after controlling for other components of Q. The paper finds that market mispricing, either at firm or industry level, indeed affects investment significantly. Moreover, the evidence is in support of both the financing and catering channel, suggesting firms adjust investment levels in attempts to time the market and to cater to the market demand. Interestingly, however, the evidence shows that the financing and catering channel can only explain the affect of industry-level mispricing on investment while neither channel seems to explain why firm-specific mispricing affects investment.

Keywords: corporate investment, market misevaluation, mispriced securities, Tobin's Q.

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I. INTRODUCTION

Whether stock market mispricing affects corporate investments is an important question since it fuels the debates over the inspirational market efficiency hypothesis. However, it is still an ongoing debate as the established evidence seems to have many issues that need to be addressed. Among others, this paper addresses the important issue of drawing spurious conclusions about the affect of market mispricing on investment from the standard investment regression where Tobin's Q is used as one of the right hand side variables. Under the standard Q theory, investment should be related to, and only to, firm's investment opportunities which is traditionally proxied for by the average Q. However, Baker et al. (2003) concerns that "differences in the sensitivity of investment to Q can arise ... because Q potentially contains three sources of variation: (i) mispricing; (ii) information about the profitability of investment and (iii) measurement error". Therefore, when Q is used as the predictor variable, an important question arises as to which components of Q really drive investment. This paper makes a significant contribution to the literature by proposing a decomposition of Q that allows empirical tests to isolate the affect of mispricing on investment from the affect of other components of Q which captures investment opportunities and financial leverage.

This paper decomposes Tobin's Q into four components which capture firm-specific mispricing, industry-level mispricing, investment opportunities and financial leverage and substitute the components into the standard investment regression. By so doing, this methodology allows the test to look at the incremental effects of mispricing component on investment in the presence of other components of the classical Q. This approach, therefore, could shed further lights into the existing evidence about the affect of mispricing on corporate investment. Using the components of Q, this paper revisits three important questions: (1) whether market mispricing affects investment, if yes, (2) whether the affect of mispricing on investment is through the financing channel, and (3) whether the affect of mispricing on investment is through the catering channel.

Using a sample of UK listed stocks during the period 1991-2008, I find that after controlling for investment opportunities, leverage and cash flows, market mispricing, both at firm and industry level, is an important driver of corporate investment. Moreover, the paper also finds evidence in support of the financing channel. Interestingly, the evidence suggests that while managers do time the market by issuing equity and investing the proceeds when their stocks are overvalued and vice versa, such behaviour is more likely when the mispricing is at industry-level but not when the mispricing is firm-specific. In addition, the paper also provides evidence in support of the catering channel. By introducing market rewards for investment as an empirical proxy for firm's motivation to cater its investment decisions to the market's needs, the paper and finds that firms which have higher rewards would have higher investment-mispricing sensitivity. Similarly to the financing channel, I find that under the catering channel it is the industry-level mispricing that provides the main source of motivation for firm to cater to the market.

This paper makes a significant contribution to the literature. Although the issues investigated are not new, the decomposition of Q allows the analysis to mitigate some important weaknesses in previous studies. Therefore, the paper significantly strengthens the claims that market mispricing does affect corporate real investment, a claim that is extremely important given the central role of capital investment as a corporate decision. Moreover, because the stream of research into the catering channel is relatively young (since Polk and Sapienza, 2009), further supports for the channel are meaningful, especially given that this paper has introduced a completely new empirical proxy for the incentives to cater. Lastly, the paper, for the first time in the literature, stresses the importance of industry-level mispricing in driving investment under both the well-documented financing and catering channel while the two channels does not seem to explain the affect of firm-specific mispricing on investment. Such insight is potentially important and could provide a starting point to inspire future research to look into the reasons behind it.

The rest of this paper proceeds as follows. Section II briefly reviews the related literature before the testable hypotheses are motivated and developed. Section III describes the data and main methodologies. Section IV presents and discusses the results while section V concludes.

II. RELATED LITERATURE AND HYPOTHESES DEVELOPMENT

Investment is one of the most important corporate decisions, which has been the subject of a large literature in finance[1]. Within this large literature, whether stock market affects corporate investment has long been an important and interesting question. This theme of research provides significant motivation for research into efficient market hypothesis because "the debates over market efficiency, exciting as they are, would not be important if the stock market did not affect real economic activity" (Morck et al., 1990). The theme can be traced back to the early work by Keynes (1936) which argues for the affect of market irrationality on real investments. Subsequent studies provide mixed evidence of whether or not stock market is an important factor that affects corporate investment. On the one hand, many studies, especially those in the 1990s, argued that the affect of the stock market on corporate investment is trivial. Morck et al. (1990) find that controlling for fundamentals and financing, stock market plays little role in driving investments. Blanchard et al. (1993) use an estimate of discounted present value of profits to proxy for fundamentals and find that after controlling for fundamentals, market valuation plays a limited role in affecting corporate investments. On the other hand, however, a lot of more recent empirical evidence are documented suggesting the stock market plays an important role in affecting corporate investment (e.g. Alzahrani, 2006; Chang et al., 2007 etc.).

There are two major theories that explain how the stock market can affect real investment decisions. First, the financing channel, which is proposed by Baker et al. (2003), links market

[1] Please see Stein (2003) for a review of this literature.

mispricing with investments through manager's market timing behaviour. Under the financing channel, overvalued firms would issue stocks and invest the proceeds, even when the marginal investment has negative NPV. Meanwhile, underpriced firms would try to avoid even positive NPV projects for they do not want to issue stocks at too cheap a price. Baker et al. (2003) and many subsequent studies (e.g. Alzahrani, 2006; Chang et al., 2007 etc.) document that firms which are more equity dependent or more financially constrained have their investments more sensitive to mispricing. The cumulative empirical evidence provides strong supports for the financing channel. Second, Polk and Sapienza (2009) propose a catering channel, which is separate from the financing channel. The catering channel predicts that when the market is overvaluing a firm, the managers will interpret that as a signal that the market demands more investments made by the firms and thus they would overinvest in attempts to cater to the demand, while on the opposite side undervaluation will result in underinvestment. Polk and Sapienza (2009) find that the investment-mispricing is higher among firms whose mispricing is more severe and those whose investors have shorter horizons, which empirically supports the catering channel.

It is also an interesting question to investigate which component of stock price really affects investments. Of particular interests is the question whether it is the rational or irrational component of stock price that drive investments. Looking at market bubbles as evidence of market mispricing, Chirinko and Schaller (1996) argue that investment is determined by fundamentals rather than by market mispricing. Bakke and Whited (2010) provide evidence that it is the private investor information that affects investments rather than market mispricing. Goyal and Yamada (2004) decompose Q into the fundamental component (which is explained by current and lagged sales growth and square sales growth) and the residual component. Looking at the Japanese market during the stock price inflation in the late 1980s, they find that the non-fundamental component drives investment more during the asset price shock period. In a similar vein, Campello and Graham (2007) looks at non-tech firms during the IT bubble in the late 1990s in the US and find that for financially unconstrained firms the affect of mispricing on investments vanished in the presence of a fundamental Q while mispricing is still a strong driver of investment decisions by constrained firms. Arguing that access to finance becomes easier during market boom, Campello and Graham (2007) interpret the evidence as in line with a financing channel suggesting constrained firms (which is likely to have more profitable investment opportunities) may take advantage of easy finance to issue stocks during market boom and use the proceeds to invest. Gilchrist et al. (2005) develop a model in which overvaluation is caused by investor opinion dispersion. They empirically find that shocks to investor opinion dispersion positively affect investment spending as well as equity issuance and Tobin's Q, which is in line with the financing channel. Alzahrani (2006) replace Q by empirical proxies for market mispricing in the standard investment regression, and find that market mispricing is strongly related with investments. Polk and Sapienza (2009) use discretionary accruals as a proxy for market mispricing and find that investments are positively related with discretionary accruals. Chang et al. (2007) use both discretionary accruals and net equity issuance as the proxies for mispricing and find evidence that corporate investments in Australia are strongly driven by market mispricing.

A key challenge for empirical studies on the affect of market mispricing on corporate investment is the proxy for mispricing. Although the market-to-book ratio is widely used in the literature as an empirical proxy for market misevaluation, it is a noisy proxy because it can also capture other factors, such as growth opportunities or the level of intangible assets (which is not recorded in book values). Ignoring market-to-book ratio, if one takes the view that mispricing is temporary, any predictor of subsequent stock returns could arguably be an empirical proxy for mispricing. Three proxies which are used quite often in the literature are discretionary accruals, net equity issuance and actual subsequent returns (e.g. Chang et al., 2007; Polk and Sapienza, 2009; Baker et al., 2003). The advantage of those proxies is they are weakly correlated with Q. Therefore, those proxies could be put to the right hand side of the standard investment regression without creating severe problem of multicollinearity.

However, there are more direct ways to measure mispricing, including measuring the deviation of stock price from its intrinsic value as estimated by a valuation model. This direct approach could make the interpretation of the evidence more focused around mispricing (e.g. Alzahrani, 2006). However, simply replacing Q by those empirical measures of mispricing could make the specification deviated from the standard Q theory.

Given the problem discussed above in existing studies on the relation between market mispricing and investment, it is worth re-visiting the issue using a proper methodology. This paper proposes a decomposition approach in which Q is decomposed into components that capture market mispricing, growth opportunities and leverage separately (please see section III.2 for details of the decomposition). Employing the decomposing approach in which mispricing is sub-decomposed into firm-level and industry-level mispricing, the paper firstly re-visits the issue of whether market mispricing affects investment:

H1a: Firm-level mispricing affects capital investment.

H1b: Industry-level mispricing affects capital investment.

The paper also tests through which channel market mispricing affects investment. In particular, following Baker et al. (2003) the paper investigates the financing channel:

H2: The investment-mispricing sensitivity is more pronounced among more financially constrained firms.

Furthermore, the paper also investigates the catering channel. Polk and Sapienza (2009) suggest that short-termism leads firms to providing what the market is demanding. Following that intuition, I hypothesize that mispricing should affect investment more when the market responds more to corporate investments.

H3: The investment-mispricing sensitivity is more pronounced among firms with stronger incentives to cater their investments to the market.

III. SAMPLE SELECTION, DESCRIPTIVE STATISTICS AND METHODOLOGIES

III.1. Sample selection

This paper employs a sample of all UK stocks which are listed on the London Stock Exchange during the period from 1991 to 2008. The UK market is chosen because despite it is one of the major markets in the world, studies on real investment decisions of UK firms in relation to the UK stock market is relatively stale as compared to other major markets such as the US or Japan. Moreover, as compared to other major markets, the UK market offers several unique characteristics that make studies in this market an important contribution to our knowledge on the issue of how firms make investment decisions. First, while during the 1991-2008 the UK economies have grown in a rate which is very similar to most of the other G7 economies (the average annual GDP growth of the UK is 2.3% as compared to 2.2% of the G7), the contribution of corporate investments to such growths is very different in the UK as compared to other developed countries. As reported in the Department for Business Innovation and Skills' Economics Report No. 9 (November 2010), the share of total corporate investments in the UK GDP growth is much smaller than that of other G7 countries during 1991-2008 (for example, the respective shares of total corporate investments in GDP growth in the UK, US and Japan are one-eighth, one-fifth and one-third, respectively). Furthermore, and as opposed to most other G7 countries (except Japan) the contribution of corporate investments to GDP growth in the UK is decreasing during the same period. Second, as compared to other G7 countries, shares of UK listed firms are more likely to be owned by financial institutions, and since financial institutions usually hold more diversified portfolios of many, the ownership in the UK tends to be more dispersed as compared to other major markets. Third, UK firms tend to pay higher and more rigid dividends, which results in less investment spending if a UK firm faces a decline in profits. Taken together, those features suggest managers in the UK have less discretion over their investment decisions. The UK is, therefore, a very interesting setting to investigate whether, and to what extent, UK managers could change investment decisions upon observing market mispricing.

The period 1991-2008 is also chosen for several reasons. First, during such period UK corporate investment has increase quite consistently (from about below 30 billion pound in 1991 to its peak of more than 60 billion pound in 2008). Second, the analysis does not go beyond the 1990s into the past to avoid possible noises from the structural differences in the UK investment environment, especially the UK market reform in the 1980s. Finally, because data for this study are downloaded from Datastream and Worldscope databases, extending the investigated period beyond 1991 do not significantly increase the power of the tests due to data availability problem which is quite severe before 1989.

To avoid survivorship bias, both live and dead stocks are selected. Similar to the common practice in this area, financial and utility firms are excluded. Stocks that have more than one type of ordinary shares are also excluded to avoid problems with apportioning firm-level earnings to each type of shares. This creates a general sample of 19,990 observations (2,857 firms) which, after imposing data availability restrictions, is used to estimate market valuation errors (section III.3).

The final sample used in the main test is derived after applying a few more restrictions. First, many earlier studies suggest that firms with little capital should be excluded (Gilchrist and Himmelberg, 1995; Almeida and Campello, 2007; Campello and Graham, 2007) because the standard investment model is not adequate for those firms. Therefore, stocks whose either beginning total asset, net plants, properties and machineries or market value is less than 1 million pounds and those whose market price as at fiscal year-end dates is below 25 pence are also dropped. This practice also ensures the sample is free from tiny stocks that could potentially inflate the scaled variables. Finally, after imposing data availability criterion, the final sample comprises of 9,316 firm-year observations (1,489 firms). All continuous variables are winsorized at the 1st and 99th percentiles to mitigate the influence of outliers[2].

III.2. Decomposition of Q and measures of market mispricing

The key innovation in terms of methodology of this paper is the use of a decomposition approach in which I decompose Q into components capturing market mispricing, growth opportunities and leverage. This approach is particularly appropriate for my test for at least two reasons. First, the decomposition approach allows the test to look separately at the components of Q that capture market mispricing, while the components of Q that capture growth opportunities and leverage are used as control variables. The beauty of this approach is that it allows us to look at the incremental affect of the mispricing component of stock price after controlling for other information contained in Q while the standard investment model (i.e. using lagged Q and cash flows as the explanatory variables) is still employed. Second, I also separate between firm-specific from industry-level valuation errors which can enable the investigation of which source of market misevaluation really drives firm's investment decisions. More specifically, Tobin's Q is commonly calculated as:

$$\boldsymbol{Q_{i,t}} = \frac{\boldsymbol{MVE_{i,t}+(TA_{i,t}-BVE_{i,t})}}{\boldsymbol{TA_{i,t}}} \tag{1}$$

where: MVE is market value of equity; TA is book value of total assets; BVE is book value of equity.

Assuming there is a intrinsic value of equity, denoted as INVAL, (1) can be written as:

$$\boldsymbol{Q_{i,t}} = \frac{\boldsymbol{(MVE_{i,t}-INVAL_{i,t})+INVAL_{i,t}+(TA_{i,t}-BVE_{i,t})}}{\boldsymbol{TA_{i,t}}} \tag{2}$$

or:

$$\boldsymbol{Q_{i,t}} = \frac{\boldsymbol{MVE_{i,t}-INVAL_{i,t}}}{\boldsymbol{TA_{i,t}}} + \frac{\boldsymbol{INVAL_{i,t}}}{\boldsymbol{TA_{i,t}}} + \frac{\boldsymbol{TA_{i,t}-BVE_{i,t}}}{\boldsymbol{TA_{i,t}}} \tag{3}$$

[2] The distribution graphs of the winsorized variables are also investigated to ensure there is indeed no significant outlier.

In (3), the first component measures the deviation of actual market value from the intrinsic value, thus it is used as a proxy for market mispricing. The second component captures growth opportunities and the last component proxies for financial leverage.

To operationize (3), one needs an empirical proxy for INVAL. I follow Rhodes–Kropf et al. (2005) approach to estimate two proxies for firm intrinsic value at firm and industry level. Rhodes-Kropf et al. (2005) show that market-to-book ratio could be decomposed into three components capturing intangible values, valuation errors and growth opportunities. Moreover, Rhodes-Kropf et al. (2005) also decompose valuation errors into two sup-components, one capture firm-specific and the other capture industry-level valuation error. Chi and Gupta (2009) find evidence that the valuation errors estimated using Rhodes-Kropf et al. (2005) approach can indeed capture some market mispricing as the trading strategies that take long in underpriced stocks and short in overpriced stocks can generate significant abnormal returns in up to three years after portfolio formation. Alzahrani (2006) also employs Rhodes-Kropf et al. (2005) approach to investigate the affect of firm-specific and industry-level mispricing on investment. However, my study is different from Alzahrani (2006) for I derive the model from a formal decomposition of Q, rather than simply replacing Q by different proxies of mispricing on the right hand side of the investment regression. Therefore, the design employed in this study is more justifiable as it emerges from the standard investment model.

Following Rhodes-Kropf et al. (2005), I estimate the following regression for each (two-digit SIC code) industry-year with at least 10 observations:

$$\boldsymbol{m_{i,t} = \alpha_{0j,t} + \alpha_{1j,t} b_{i,t} + \alpha_{2j,t} ni^{+}_{i,t} + \alpha_{3j,t} I_{(<0)} ni^{+}_{i,t} + \alpha_{4j,t} LEV_{i,t} + \varepsilon_{i,t}} \quad (4)$$

where $m_{i,t}$ is market value of firm *i* in year *t*; $b_{i,t}$ is book value of firm *i* in year *t*; $ni^{+}_{i,t}$ is log value of absolute value of net income; $I_{(<0)}$ is a dummy variable that takes the value of one if net income is negative and zero otherwise (which allows negative earnings to enter the estimation while net incomes still enter the regression as log values to account for its well-known right-skewness); $LEV_{i,t}$ is book leverage of firm *i* in year *t*, defined as the ratio of total liabilities to total assets (the lower letters denote logs of the concerned variables).

The regression is run using a sample of all UK ordinary stocks with available data which are listed on the London stock exchange, excluding financial and utilities firms and firms with more than one type of ordinary shares. For each observation, the firm-specific intrinsic value, denoted $v(\theta_{i,t};\alpha_{j,t})$, is calculated as the predicted value of (4) using the estimated coefficients from the corresponding industry-year regression:

$$\boldsymbol{v(\theta_{i,t};\alpha_{j,t}) = \hat{\alpha}_{0j,t} + \hat{\alpha}_{1j,t}b_{i,t} + \hat{\alpha}_{2j,t}ni^{+}_{i,t} + \hat{\alpha}_{3j,t}I_{(<0)}ni^{+}_{i,t} + \hat{\alpha}_{4j,t}LEV_{i,t}} \quad (5)$$

To estimate industry-level intrinsic values, for each industry I average the estimated coefficients from equation (7) across time to firstly obtain the long-run industry valuation multiples:

$$\boldsymbol{\bar{\alpha}_{kj} = \frac{1}{T}\sum \hat{\alpha}_{kj,t}} \quad (\mathrm{k} = 0, 1, 2, 3, 4) \quad (6)$$

The $\bar{\alpha}_{kj}$ are then used to estimate industry-level intrinsic values, denoted $v(\theta_{i,t};\alpha_{j})$:

$$\boldsymbol{v(\theta_{i,t};\alpha_{j}) = \bar{\alpha}_{0j} + \bar{\alpha}_{1j}b_{i,t} + \bar{\alpha}_{2j}ni^{+}_{i,t} + \bar{\alpha}_{3j}I_{(<0)}ni^{+}_{i,t} + \bar{\alpha}_{4j}LEV_{i,t}} \quad (7)$$

It is important that the measures of intrinsic values are estimated without severe deficiencies. Panel A of Table 1 reports the means across industries of $\bar{\alpha}_{kj}$ together with the t-statistics calculated using standard errors of the mean. All the coefficients have the signs as predicted by Rhodes-Kropf et al. (2005). Moreover, the magnitudes and statistical significance of the coefficients are also very much comparable to those reported by Rhodes-Kropf et al. (2005), except only for $\bar{\alpha}_4$. The adjusted R^2 is also very high (86%), which is again similar to that reported in Rhodes-Kropf et al. (2005). Unreported results also show that on an industry-by-industry basis, there is no significantly large or small values of the coefficients which could potentially bias the means as reported. Panel B of Table 1 reports the main descriptive statistics of the estimated measures of firm-specific and industry-level intrinsic values together with the log of actual market values for the whole sample employed to estimate them. The means of the three measures are very much similar, with very low ANOVA F statistic (0.435), suggesting they are statistically indifferent. This implies roughly half of the observations have intrinsic values higher than actual market values, which are compensated by the lower intrinsic values of the other half. Overall, the statistics suggest that my measures of valuation are constructed appropriately.

[INSERT TABLE 1 HERE]

Because (5) and (7) give intrinsic values in log form (to take into account the well-known skewed distribution of accounting information), before proceeding those intrinsic values are converted into sterling value. Let FIV and IIV be firm-specific and industry-level intrinsic values in sterling, respectively, then substituting them into (3) gives:

$$\boldsymbol{Q_{i,t}} = \frac{MVE_{i,t}-FIV_{i,t}}{TA_{i,t}} + \frac{FIV_{i,t}-IIV_{i,t}}{TA_{i,t}} + \frac{IIV_{i,t}}{TA_{i,t}} + \frac{TA_{i,t}-BVE_{i,t}}{TA_{i,t}} \tag{8}$$

In (8), the first and second component captures firm-specific and industry-level mispricing, respectively; the third component is a proxy for growth opportunities and the last one proxies for financial leverage. Because the decomposition of Q is the central contribution of this paper, it is important to understand the nature of the decomposition approach. One important question is which component, if any, is the main source of variation in Q. Table 2 reports the mean values of each component across quintiles of stocks sorted by Q. It could be observed that firm-specific mispricing, industry-level mispricing and growth opportunities increase monotonically as Q increases resulting in the means in the fifth quintile are all statistically different from those in the first quintile. However, leverage does not seem to vary in a systematic manner (although the difference between the first and last quintile is still statistically significant). Therefore, the analysis suggests that only firm-specific mispricing, industry-level mispricing and growth opportunities are the source of variation in Q. It implies that firms with higher Q tend to be more overvalued, both at firm and industry level, and tend to have more growth opportunities, but they do not have higher leverage.

[INSERT TABLE 2 HERE]

III.3. Descriptive statistics and correlations

Table 3 provides some descriptive statistics of the main variables. The mean and median capital expenditures as a percentage of total assets are 7.27% and 4.96%, respectively. The mean of Tobin's Q is 1.8114. It should be noted that none of the mispricing components is averaged to zero because the sample used to estimate intrinsic values is larger than the final sample used for the main tests. Overall, the statistics are comparable to prior studies and suggest no severe problem.

[INSERT TABLE 3 HERE]

Table 4 reports correlation coefficients between the main variables. In line with the established literature, CAPEX is highly correlated with Q and CF (correlation coefficients of 0.189 and 0.191, respectively, and both are significant at 1% level). Looking at the components of Q, CAPEX is positively related with firm-specific mispricing, industry-level mispricing, growth opportunities and negatively related with leverage. Moreover, the correlations between the four components of Q are not very high suggesting each component captures a separate aspect of Q.

[INSERT TABLE 4 HERE]

IV. EMPIRICAL RESULTS

IV.1. Investment-mispricing sensitivity

The standard specification of tests of investment-stock price sensitivity involves regressing investments on a proxy for investment opportunities and cash flows. Modigliani and Miller (1958) suggest that investment is a function of only investment opportunities in a perfect capital market. Theoretically, Tobin's (1969) marginal Q is generally accepted as a summary measure of investment opportunities. Empirically, however, because marginal Q is not observable, average Q (which is the ratio of market value of assets to book value of assets) is often used as a proxy for investment opportunities. Following Fazzari et al. (1988), subsequent research often include cash flows as a proxy for internal sources of finance. Therefore, the standard investment regression that is most commonly used in the literature is:

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta Q_{i,t-1} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (9)$$

Let call $MVE_{i,t} - FIV_{i,t}$ as $FVE_{i,t}$ and $FIV_{i,t} - IIV_{i,t}$ as $IVE_{i,t}$, respectively, then substituting (8) into (9) gives:

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta_1 \frac{FVE_{i,t-1}}{TA_{i,t-1}} + \beta_2 \frac{IVE_{i,t-1}}{TA_{i,t-1}} + \beta_3 \frac{IIV_{i,t-1}}{TA_{i,t-1}} + \beta_4 \frac{TA_{i,t-1} - BVE_{i,t-1}}{TA_{i,t-1}} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (10)$$

Using (10) as the baseline regression, hypotheses H1a and H1b predict that β_1 and β_2 should be significantly positive. Table 5 reports the results of estimating equation (9) and (10) using the whole sample of 9,316 observations. The results of (9) are very much in line with the established literature suggesting Q and cash flows are important determinants of investment. However, the main contribution of this paper lies with the results of estimating (10). When Q is decomposed, it could be observed that investment is sensitive to all four components. In line with expectation, firms with higher growth opportunities and lower leverage tend to have higher investment as the coefficients β_3 and β_4 are 0.0251 and -0.0217, respectively, and both are statistically significant. The main focus is on the coefficients on FVE and IVE. A one-standard-deviation change in FVE moves the investment ratio by 0.0086 (0.0091 x 0.9423 = 0.0086). The affect of IVE on investment is very similar with a one-standard-deviation change in IVE moves the investment ratio by 0.0070 (0.0175 x 0.3991). Overall, the results provide strong supports for H1a and H1b suggesting market mispricing, either at firm or industry level, is an important determinant of corporate investments.

[INSERT TABLE 5 HERE]

IV.2. Test of the financing channel

To investigate the financing channel, following Baker et al. (2003) most US studies employ KZ index as an empirical proxy for financial constraints. However, KZ index is specifically developed for the US market (Kaplan and Zingales, 1997). Therefore, because this paper looks at the UK market, a different proxy is needed to test hypothesis H2. I employ size (measured as total assets) as a proxy for financial constraints. Size is found to be negatively related with cost of capitals (e.g. Hennessy and Whited, 2007). It implies that smaller firms could face more difficulties to acquire external finance than larger firms, which makes size a good empirical proxy for financial constraints. In fact, many prior studies also employ size for this purpose (e.g. Chang et al., 2007; Bakke and Whited, 2010 etc.). Each year, I rank all firms within the same two-digit SIC code into five quintiles based on total assets. Then equations (9) and (10) are estimated within each of the quintiles to test for H2. The financing hypothesis (H2) predicts that β in (9) and β_1, β_2 in (10) should be larger among more financially constrained (i.e. smaller) firms.

Table 6 reports the results of estimating equation (9) and (10) across sub-samples sorted by size. The results of estimating (9) are very much in line with the evidence provided by Baker et al. (2003). The coefficients on Q decrease systematically when firms are less financially constrained (i.e. when one goes towards larger firms). The investment-Q sensitivity of constrained firms is almost double that of unconstrained firms and the differences are statistically significant (t-statistic is 1.769). The most interesting evidence of this paper is reported when Q is decomposed. Of the four components of Q, the evidence suggests that only the sensitivity of investment to industry-level mispricing component decrease monotonically as one moves towards less financially constrained firms. Among smallest firms the sensitivity of investment to industry-level mispricing is almost triple that of the largest firms (0.0296 compared to 0.0105), and the difference is statistically significant at the 5% level (t-statistic is 2.225). Meanwhile, the sensitivities of investment to firm-level mispricing, growth opportunities and leverage seem to vary unsystematically across size quintiles and the difference between the lowest and highest quintiles are all statistically insignificant. Overall the evidence is in strong support of H2 suggesting the existence of the financing channel.

The evidence presented in this section makes to significant incremental contribution to the extant literature. First, the evidence reinforces the established evidence suggesting the financing channel that creates the investment-Q sensitivity (e.g. Baker et al., 2003) does exist. In particular, my evidence affirms that it is indeed the mispricing component of Q (rather than growth opportunities) that make the investment-Q sensitivity higher among more financially constrained firms. Second, it is interesting to observe that of the two sources of mispricing, only the industry-level mispricing drives the financing channel. It implies that when an entire industry is overheated, it is more likely that managers will time the market by issuing equity and park the proceeds in capital investments while the market timing behaviour is less likely if the mispricing is firm-specific. On the contrary, the evidence also suggests that as an industry is getting colder, more positive NPV projects are likely to be rejected while firms do not reduce investment on the basis that the market is undervalued their stocks firm-specifically.

[INSERT TABLE 6 HERE]

IV.3. Test of the catering channel

Polk and Sapienza (2009) test the catering channel by comparing the investment-mispricing sensitivity of firms with shorter sighted investors with that of firms whose investors have longer horizon. They also compare the sensitivity of firms with more research and development expenses with those whose such expenses are less spent. The intuition behind such designs is that shorter sighted investors and the presence of opacity create more motivations for firm to cater. This paper takes a more direct way test of the catering channel. If the catering channel exists, firms would cater more when the market rewards for catering is larger. Therefore, to test H3, I construct a measure of market reward to firm's capital expenditures as follows:

$$\boldsymbol{REW}_{i,t} = \frac{MB_{i,t+1} - MB_{i,t}}{CAPEX_{i,t}} \quad (11)$$

where: MB is market-to-book ratio, which is calculated as market value of equity scaled by book value of equity, both measured at fiscal year-end.

As designed, REW can be interpreted as market rewards per pound invested. Each year, I rank all firms within the same two-digit SIC code into five quintiles based on REW and run regressions (9) and (10) within each quintile to test for H3. Hypothesis H3 predicts that β in (9) and β_1, β_2 in (10) should be larger among firms which are more rewarded for making capital investments.

Table 7 reports the results of estimating equation (9) and (10) across sub-samples sorted by market rewards for investments. The results of estimating equation (9) show that investment is more sensitive to Q when the market rewards for investment is higher which is in line with the catering hypothesis. When Q is decomposed, only the sensitivity of investments to the industry-level mispricing component varies monotonically when market rewards change. The sensitivity of investments to industry-level mispricing in the highest market rewards quintile is more than double that in the lowest quintile and the difference is statistically significant at 1% level (t-statistic is 2.602). Meanwhile, the sensitivities of investments to firm-specific mispricing, growth opportunities and leverage vary unsystematically across market rewards quintiles and the differences between the top and bottom quintiles are statistically insignificant. In general, the evidence is in line with H3 supporting the catering channel. Moreover, this paper also suggests a more interesting story showing that under the catering channel, the main source of motivation for firms to cater is industry-level mispricing.

[INSERT TABLE 7 HERE]

V. CONCLUSIONS

Using a sample of UK listed stocks during the period 1991-2008, this paper revisits the investment-mispricing sensitivity using a decomposition of Q approach. More specifically, Tobin's Q is decomposed into four components, which are firm-specific mispricing, industry-level mispricing, growth opportunities and leverage. By replacing the components of Q into the standard investment model, I find that investment is indeed sensitive to the mispricing components of Q, at both firm and industry levels, after controlling for growth opportunities, leverage and cash flows. Furthermore, in line with the financing channel (Baker et al., 2003) the paper finds that while smaller stocks generally have investment more sensitive to mispricing than larger stocks, it is the industry-level mispricing that makes the difference. In addition, the paper finds evidence which is in line with the catering channel (Polk and Sapienza, 2009) where the investment-mispricing sensitivity is found to be largest among firms which are most rewarded by the market for making investment. Similarly to the financing channel, the evidence suggests that the industry-level mispricing is the main source of motivation for managers to cater to the market. The observation that both the financing and catering channels seem unable to explain the influence of firm-specific mispricing on investment is very interesting. Further research is needed to investigate the reasons behind it.

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Table 1

Average Long-Run Industry Valuation Multiples and Comparison between Firm-Specific, Industry-Level Intrinsic Values and Actual Market Values

Panel A: Average long-run industry valuation multiples						
	Intercept	$b_{i,t}$	$ni^{+}_{i,t}$	$I_{(<0)}ni^{+}_{i,t}$	$LEV_{i,t}$	**Adj.** R^2
Mean	1.869***	0.550***	0.418***	-0.067***	-0.027	0.860
t-stats	12.864	20.226	13.745	-6.656	-0.149	

Panel B: Firm-specific and industry-level market valuation and actual market values (n = 17,364)			
	Firm-specific intrinsic value	**Industry-level intrinsic value**	**Log of actual market value**
Mean	10.642	10.626	10.642
Median	10.482	10.478	10.461
Maximum	16.561	16.015	15.878
Minimum	4.480	3.127	0.000
Std. Dev.	1.786	1.767	1.905
ANOVA F statistic	0.435		
P-value	0.648		

Notes:

Firm-specific intrinsic value, denoted $\mathbf{v}(\boldsymbol{\theta}_{\mathbf{i,t}};\boldsymbol{\alpha}_{\mathbf{j,t}})$, is defined as: $\mathrm{v}(\theta_{i,t};\alpha_{j,t}) = \hat{\alpha}_{0j,t} + \hat{\alpha}_{1j,t}b_{i,t} + \hat{\alpha}_{2j,t}ni^{+}_{i,t} + \hat{\alpha}_{3j,t}I_{(<0)}ni^{+}_{i,t} + \hat{\alpha}_{4j,t}LEV_{i,t}$; where $\hat{\alpha}_{kj,t}$ (k = 0, 1, 2, 3, 4) are estimated within each (two-digit SIC code) industry-year with at least 10 observations of available data excluding financial, utilities firms and firms with more than one type of ordinary shares: $m_{i,t} = \alpha_{0j,t} + \alpha_{1j,t}b_{i,t} + \alpha_{2j,t}ni^{+}_{i,t} + \alpha_{3j,t}I_{(<0)}ni^{+}_{i,t} + \alpha_{4j,t}LEV_{i,t} + \varepsilon_{i,t}$ (where: **m** is log of market values at fiscal year-end, **b** is log of book values, $\mathbf{ni^{+}}$ is log of absolute value of net incomes, $\mathbf{I_{(<0)}}$ is an indicator of loss firms, defined as a dummy variable that takes the value of one if a firm's net income is negative and zero otherwise, **LEV** is book leverage ratio, defined as the ratio of total liabilities to total assets).

Industry-level intrinsic value, denoted $\mathbf{v}(\boldsymbol{\theta}_{\mathbf{i,t}};\boldsymbol{\alpha}_{\mathbf{j}})$, is defined as: $\mathrm{v}(\theta_{i,t};\alpha_{j}) = \bar{\alpha}_{0j} + \bar{\alpha}_{1j}b_{i,t} + \bar{\alpha}_{2j}ni^{+}_{i,t} + \bar{\alpha}_{3j}I_{(<0)}ni^{+}_{i,t} + \bar{\alpha}_{4j}LEV_{i,t}$ (where $\bar{\alpha}_{kj}$ are the averages across 19 years from 1990 to 2008 of $\hat{\alpha}_{kj,t}$).

Panel A reports the across-industry means of long-run industry valuation multiples (the $\bar{\alpha}_{kj}$), together with t-statistics calculated using standard errors of the means.

Panel B reports basic descriptive statistics of firm-specific, industry-level intrinsic values and log of actual market values for the sample employed to estimate intrinsic values and results of an ANOVA F test that compares their means.

*, **, *** denotes two-tailed significance at 10%, 5%, 1% levels, respectively.

Table 2

Q and its components across Q quintiles

	Q1	Q2	Q3	Q4	Q5	Q5 - Q1	t-stat
Q_{t-1}	0.9477	1.2349	1.5389	1.9881	3.3427	2.3950	53.737***
FVE_{t-1}/TA_{t-1}	-0.3291	-0.1858	-0.0313	0.2673	1.2631	1.5922	45.672***
IVE_{t-1}/TA_{t-1}	0.0238	0.0449	0.0768	0.1165	0.2216	0.1978	13.425***
IIV_{t-1}/TA_{t-1}	0.7859	0.8366	0.9374	1.0492	1.2759	0.4900	28.485***
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$	0.4791	0.5459	0.5539	0.5359	0.4985	0.0194	3.047***

Notes:

Q is Tobin's Q, which is calculated as market value of equity plus total assets minus book value of equity, all over total assets; FVE is firm-specific mispricing, measured as the deviation of actual market value of equity from firm-specific intrinsic value of equity; IVE is industry-level mispricing, measured as the deviation of firm-specific intrinsic values from industry-level intrinsic values; IIV is industry-level intrinsic values; TA is total assets; BVE is book value of equity. Definitions of firm-specific and industry-level intrinsic value of equity are provided in the notes to Table 1.

Each year, stocks in same 2-digit SIC code are sorted into five quintile based on Q. This table reports the means of Q and its four components across those five quintiles. The last two columns report the difference between the mean in the last quintile and the first quintile together with the t-statistic under the null that the difference is zero.

Table 3

Descriptive statistics (n = 9,316)

	Mean	Median	Maximum	Minimum	Std. Dev.
$CAPEX_t/TA_{t-1}$	0.0727	0.0496	0.4823	0.0017	0.0796
Q_{t-1}	1.8114	1.4277	8.8003	0.6429	1.2697
FVE_{t-1}/TA_{t-1}	0.1976	0.0171	5.5110	-1.5600	0.9423
IVE_{t-1}/TA_{t-1}	0.0968	0.0485	1.8248	-0.8133	0.3991
IIV_{t-1}/TA_{t-1}	0.9772	0.8829	2.8935	0.1208	0.5383
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$	0.5226	0.5328	0.9407	0.0581	0.1932
CF_t/TA_{t-1}	0.0836	0.0993	0.3878	-0.5553	0.1396
TA_t (£ Million)	481	74	9,247	4	1,316
REW_t	-0.0002	0.0000	0.0208	-0.0295	0.0045

Notes:

CAPEX is capital expenditures; TA is total assets; Q is Tobin's Q, which is calculated as market value of equity plus total assets minus book value of equity, all over total assets; FVE is firm-specific mispricing, measured as the deviation of actual market value of equity from firm-specific intrinsic value of equity; IVE is industry-level mispricing, measured as the deviation of firm-specific intrinsic values from industry-level intrinsic values; IIV is industry-level intrinsic values; BVE is book value of equity; CF is net operating cash flows; REW is market rewards to investments, measured as change in market-to-book ratio divided by capital expenditures.

Table 4

Correlations

		(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
$CAPEX_t/TA_{t-1}$	(1)	1.0000								
Q_{t-1}	(2)	0.1890	1.0000							
FVE_{t-1}/TA_{t-1}	(3)	0.1259	0.8517	1.0000						
IVE_{t-1}/TA_{t-1}	(4)	0.1130	0.4087	0.0995	1.0000					
IIV_{t-1}/TA_{t-1}	(5)	0.1836	0.4932	0.1501	0.0911	1.0000				
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$	(6)	-0.1361	-0.1020	-0.0511	-0.0886	-0.4397	1.0000			
CF_t/TA_{t-1}	(7)	0.1907	0.0719	0.0280	**0.0010**	0.0903	0.0971	1.0000		
TA_t	(8)	-0.0668	-0.0184	-0.0173	-0.0390	-0.1737	0.1441	0.0405	1.0000	
REW_t	(9)	**0.0129**	-0.0925	-0.0685	-0.0649	-0.0378	***-0.0251***	**0.0006**	**0.0131**	1.0000

Notes:

All coefficients are significant at 1% level or better, except those in bold and italic which are significant at 5% level and those in bold which are insignificant. Definitions of variables are provided in the notes to Table 3.

Table 5

Regression of capital expenditures on Q, components of Q and cash flows

	Eq. (9)		Eq. (10)	
	Coef.	t-stat	Coef.	t-stat
C	0.0448	13.453***	0.0500	5.57***
Q_{t-1}	0.0118	7.513***		
FVE_{t-1}/TA_{t-1}			0.0091	6.637***
IVE_{t-1}/TA_{t-1}			0.0175	4.876***
IIV_{t-1}/TA_{t-1}			0.0251	7.67***
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$			-0.0217	-1.644*
CF_t/TA_{t-1}	0.0784	5.458***	0.0719	5.504***
Adj. R2	0.5765		0.5832	

Notes:

This table reports the results of estimating the following equations.

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta Q_{i,t-1} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (9)$$

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta_1 \frac{FVE_{i,t-1}}{TA_{i,t-1}} + \beta_2 \frac{IVE_{i,t-1}}{TA_{i,t-1}} + \beta_3 \frac{IIV_{i,t-1}}{TA_{i,t-1}} + \beta_4 \frac{TA_{i,t-1} - BVE_{i,t-1}}{TA_{i,t-1}} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (10)$$

The t-statistics are calculated using robust standard errors clustered by both firms and time. *, **, *** denotes two-tailed significance at 10%, 5%, 1% levels, respectively. Definitions of variables are provided in the notes to Table 3.

Table 6

Investment-mispricing sensitivity across groups sorted by firm size

	Small		Q2		Q3		Q4		Large	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Panel A: Equation (9)										
C	0.0377	5.464***	0.0541	10.299***	0.0515	8.275***	0.0478	10.247***	0.0439	8.142***
Q_{t-1}	0.0164	4.332***	0.0094	4.998***	0.0100	3.502***	0.0117	5.343***	0.0087	3.145***
CF_t/TA_{t-1}	0.0718	3.429***	0.0669	1.727*	0.0924	2.264**	0.0477	1.446	0.0501	2.489**
Panel B: Equation (10)										
C	0.0419	2.402**	0.0390	1.652*	0.0601	2.908***	0.0972	4.355***	0.0505	5.072***
FVE_{t-1}/TA_{t-1}	0.0140	5.181***	0.0043	1.411	0.0054	1.478	0.0133	5.455***	0.0073	2.215**
IVE_{t-1}/TA_{t-1}	0.0296	3.772***	0.0068	1.492	0.0178	2.284**	0.0121	1.416	0.0105	2.085**
IIV_{t-1}/TA_{t-1}	0.0250	4.087***	0.0310	3.805***	0.0217	3.053***	0.0178	2.651***	0.0254	5.497***
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$	-0.0148	-0.461	-0.0006	-0.016	-0.0274	-0.915	-0.0910	-2.62***	-0.0228	-1.59
CF_t/TA_{t-1}	0.0653	3.164***	0.0563	1.485	0.0848	2.232**	0.0479	2.02**	0.0410	2.281**

Notes:

Each year, stocks in same 2-digit SIC code are sorted into five quintile based on total assets. This table reports the results of estimating the following equations in each of those quintiles.

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta Q_{i,t-1} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (9)$$

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta_1 \frac{FVE_{i,t-1}}{TA_{i,t-1}} + \beta_2 \frac{IVE_{i,t-1}}{TA_{i,t-1}} + \beta_3 \frac{IIV_{i,t-1}}{TA_{i,t-1}} + \beta_4 \frac{TA_{i,t-1} - BVE_{i,t-1}}{TA_{i,t-1}} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (10)$$

The t-statistics are calculated using robust standard errors clustered by both firms and time. *, **, *** denotes two-tailed significance at 10%, 5%, 1% levels, respectively. Definitions of variables are provided in the notes to Table 3.

Table 7

Investment-mispricing sensitivity across groups sorted by market rewards for investments

	Low		Q2		Q3		Q4		High	
	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat	Coef.	t-stat
Panel A: Equation (9)										
C	0.0449	10.297***	0.0438	5.143***	0.0450	4.517***	0.0419	5.238***	0.0359	4.491***
Q_{t-1}	0.0068	3.754***	0.0138	2.902***	0.0182	2.961***	0.0128	3.069***	0.0110	2.527**
CF_t/TA_{t-1}	0.0334	1.185	0.1329	3.122***	0.0970	2.614***	0.1448	4.683***	0.0482	2.191**
Panel B: Equation (10)										
C	0.0450	3.378***	0.0431	1.756*	0.0351	1.34	0.0628	3.317***	0.0304	1.039
FVE_{t-1}/TA_{t-1}	0.0053	2.724***	0.0120	2.618***	0.0164	2.832***	0.0099	2.009**	0.0085	2.009**
IVE_{t-1}/TA_{t-1}	0.0109	1.498	0.0145	1.208	0.0192	1.846*	0.0153	1.807*	0.0226	2.248**
IIV_{t-1}/TA_{t-1}	0.0128	2.525**	0.0249	2.25**	0.0478	4.372***	0.0279	3.108***	0.0169	1.689*
$(TA_{i,t-1} - BVE_{i,t-1})/TA_{t-1}$	-0.0047	-0.223	-0.0031	-0.085	-0.0091	-0.248	-0.0517	-1.731*	0.0095	0.235
CF_t/TA_{t-1}	0.0315	1.107	0.1248	2.807***	0.0696	2.114**	0.1365	4.183***	0.0442	2.05**

Notes:

Each year, stocks in same 2-digit SIC code are sorted into five quintile based on market rewards for investment (REW). This table reports the results of estimating the following equations in each of those quintiles.

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta Q_{i,t-1} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (9)$$

$$\frac{CAPEX_{i,t}}{TA_{i,t-1}} = \alpha + \beta_1 \frac{FVE_{i,t-1}}{TA_{i,t-1}} + \beta_2 \frac{IVE_{i,t-1}}{TA_{i,t-1}} + \beta_3 \frac{IIV_{i,t-1}}{TA_{i,t-1}} + \beta_4 \frac{TA_{i,t-1} - BVE_{i,t-1}}{TA_{i,t-1}} + \gamma \frac{CF_{i,t}}{TA_{i,t-1}} + \sum_i firm_i + \sum_t year_t + \varepsilon_{i,t} \quad (10)$$

The t-statistics are calculated using robust standard errors clustered by both firms and time. *, **, *** denotes two-tailed significance at 10%, 5%, 1% levels, respectively. Definitions of variables are provided in the notes to Table 3.