Allocative Efficiency of the Philippine Stock Market

By Rodolfo Q. Aquino*

Abstract

This essay looks at the allocative efficiency of the Philippine stock market using Tobin’s $q$. The econometric evidence resulting from the cross section analysis conducted in this essay supports the view that the stock market is not allocationally or Pareto efficient. The hypothesis that the measured marginal $q$ is positively related to investment at the firm level is not accepted.

Without discounting the possible role of measurement error, the main explanations for the unfavorable results offered are market informational inefficiency and the inherent conflict of interests between ordinary investors and controlling shareholders. When the market is not efficient, for example, proceeds from new equity issues (IPOs) such as those made during the boom period of 1994-97 when average $q$’s were high (and equity cost of capital is low) can be used to lower the firm’s average cost of capital and not necessarily to fund new investments. If controlling shareholders (and existing minority shareholders) are able to liquidate part of their holdings at high prices while retaining control, then this constitutes wealth transfers from new to old shareholders at no cost to the controlling shareholders.

Investments are also found to be related positively with the ownership percentage of firms’ controlling shareholders or shareholder groups. This indicates that, at least for the period covered by the study, investments are made on the basis of favorable information known only to the controlling group. This information, however, is not immediately known to ordinary investors and therefore only incorporated into prices and marginal $q$ with some lag. Thus, even if the market is relatively efficient (say, with respect to prices and all publicly known information), Tobin’s $q$ as a model of investment can still fail empirically because the firm’s investment behavior is subject to the inherent conflict of interests between controlling shareholders and ordinary investors.

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Introduction

This essay looks at the allocative efficiency of the Philippine stock market. Tobin’s q (Tobin, 1969) suggests an approach to evaluate the allocative efficiency of the local stock market. Tobin’s q is defined as the ratio of the market value of outstanding claims on the firm (MV) to the replacement cost of its net assets (RC). The intuition is that values of q greater than one, on the margin, should stimulate more investments and values less than one should correspondingly discourage investments until q equals unity. Note that, as will be shown later, the present value model of stock prices is an equivalent concept to Tobin’s q. Thus, if the local stock market is allocationally efficient, price and returns signals from the market, working through Tobin’s q, should have a positive effect on investments. In particular, this essay will

- test the hypothesis that firm-level investments in a cross section of firms comprising the Philippine stock market composite index (Phisix) can be explained by Tobin’s q. The period covered is 1994-1999. The test involves estimating the average and marginal q’s of firms from available firm-level financial data.
- provide a plausible explanation of the empirical results obtained.

The following section (Section 2) reviews the literature on Tobin’s q and investment as well as available empirical studies. Section 3 gives an overview of the q theory of investment and Section 4 summarizes the data and methodology used in the empirical study. In Section 5, firm-level investments are related to both average and marginal q. Section 6 reviews and provides explanation for the empirical results and Section 7 concludes.

2 Literature Review

Dixit and Pindyck (1994) summarized the neoclassical theory of investment in the following rule: invest until the value of an incremental unit of capital is just equal to its cost. There are two equivalent approaches in the literature operationalizing this theory. The first follows Jorgenson (1963) where the per-period value of an incremental unit of capital or its marginal product is equated with the per-period rental cost or user cost of capital. The other formulation, due to Tobin (1969), compares the capitalized value of the marginal investment to its purchase cost. The essential difference between the two is adjustment costs. Under the Jorgensonian approach, adjustment is instantaneous such that q is always unity. In the Tobin approach, it is the deviation of q from unity that explains investment. Chirinko (1993) showed that, with adjustment costs, q is a sufficient statistic for explaining investment behavior. Tobin’s q is the subject of empirical investigation in this essay.

A more modern approach, usually referred to as the real options approach to investment because of the use of concepts developed in financial options theory, can be regarded as an extension to Tobin’s q. A good introduction to this approach is Dixit and Pindyck (1994). Essentially a theory of investment under uncertainty, the value of a project under this approach is the capitalized value of the marginal investment, as in Tobin’s q, minus the option value forgone from implementing the project now. Thus, the option criterion is more stringent: marginal q must exceed unity by a sufficient margin which is determined by many factors such as the form of the production function and the distribution of the various project parameters. Abel (1993) demonstrated that as in the basic q theory investment remains to be a non-decreasing function of q. However, there is a region above unity where investment is zero.

Going back to Tobin’s q and Pareto efficiency, Dow and Gorton (1995) noted that most of the literature has focused more on the role of the stock market in the allocation of risk (see for example Stiglitz, 1981) and less on its role in guiding investment decisions of firms. The local research literature, for instance, has focused on the informational efficiency of the local bourse, i.e., how quickly market players factor in revealed information such as past prices, dividends and earnings announcements, and announcements of macroeconomic and monetary information into
current stock prices. There is almost none that looks at allocative (or Pareto) efficiency which deals with the other direction of the relationship.

Grossman and Stiglitz (1980) pointed out that an exact informationally efficient market is an impossibility. The argument is that the only way informed traders can earn a return on information gathering is if they can use the information to generate better returns than uninformed traders. Thus, if all information were already fully reflected in current prices, then obtaining information would have a zero return and nobody would collect information. Uncollected information could not then be reflected in prices. Mishkin (1983) stated that although the rational expectations or efficient markets condition may not hold exactly, it is still an extremely useful approximation for economic analysis. In any case, if price adjustments were instantaneous, as a perfectly efficient market would indicate, there would be no discernible signals to base investment decisions on. Fischer and Merton (1984) asserted quite strongly that while the efficient market hypothesis is not a sufficient condition for allocative or Pareto efficiency, it is, nonetheless, a necessary condition for optimal allocation. Merton (1987), however, accepts the probability, however small, that stock prices deviate substantially from fundamental values and still lead to Pareto optimal allocation of investments. Even more strongly, Stiglitz (1981) asserted that informational efficiency is neither necessary nor sufficient for the Pareto optimality of the economy1. Thus, a near-enough market efficiency may be sufficient for the market signals to be reliable indicators of returns as well as be discernible so as to influence real activity.

Early studies since Tobin (1969) initially suggested what is now referred to as the q theory of investment have used average q as the main explanatory variable for investment. After Hayashi (1982) showed the conditions under which average q and marginal q are equivalent, the use of average q continued with explicitly citing, but not empirically testing, Hayashi’s results. Chirinko (1993) showed that q is a sufficient statistic for investment. However, in his review of the literature on the empirical implementation of the q theory, he concluded that, in terms of statistical significance of q as sole explanatory variable and the fit of the equation, the performance of the model had been generally unsatisfactory. He added that the results “are based on U.S. data but a broadly similar pattern has been reported from other countries.” A survey of accessible literature on Tobin’s q and investment, both at the firm and aggregate level, summarized in Table 1 slightly favors q when used with other explanatory variables. Barro (1990) used a variable representing the change in q over time as a “q-type variable.” This is a related but not equivalent measure to marginal q. Other researchers, e.g., Kopcke and Howrey (1994), used current and lagged values of average q which can be considered as similar to the measure used by Barro. Blanchard, Rhee and Summers (1993) used a forward-looking concept of q which represents the firm managers’ valuation of marginal projects although they used a proxy computed based on stock market data. Aquino (1999-2000) and Dumev, Morck and Yeung (2001) used a cross sectional estimate of marginal q adopting the two-pass procedure commonly used in estimating the parameters of the capital asset pricing model or CAPM. This procedure was initially used by Fama and MacBeth (1973).

The advantage of procedures based on average q is that time series studies are feasible. By contrast, only cross section studies can be done with the two-pass procedure. For instance, Aquino (1996-2000) applied this procedure for selected firms in the Philippines covering the period 1993-1998 while Dumev et al (2001) applied this for selected U. S. firms for the period 1993-1997. The disadvantage in using average q can be summarized in Caballero (1997) as he

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1 Stiglitz’ paper was actually an invited paper entitled “Pareto Optimality and Competition” under the general section of “The Allocation Role of the Stock Market.” For some reason, it has always been cited under the latter title. It is cited in the references here under the customary title.
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<td>Hayashi, 1982</td>
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<td>Barro, 1990</td>
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<td>Hoshi, Kashyap and Scharfsten, 1991</td>
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<td>Blanchard, Rhee and Summers, 1993</td>
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<td>Kopcke and Howrey, 1994</td>
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<td>Average $q$ Ratio of market value to book value.</td>
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<td>Aquino, 1999-2000</td>
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<td>Firm-level investment rate is regressed against marginal q and other financial variables. Marginal q is not found statistically significant but debt-equity ratio and fixed assets to total assets ratio are, suggesting that financial constraints are important determinants of investment.</td>
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<td>Durnev, Morck and Yeung, 2001</td>
<td>Marginal q</td>
<td>Marginal q estimated as the slope coefficient of regressing changes in market value with changes in estimated replacement cost and lagged average q.</td>
<td>Measures of firm-specific information are regressed against distance measures of marginal q from one to test to what extent firms allocate capital optimally. Results are mixed.</td>
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expressed his “mixed feelings about the use of Hayashi’s results to justify the use of average q in empirical work even though the conditions for the equivalence of average and marginal q are not nearly satisfied in the industries or firms studied.” He added that while marginal q is the appropriate concept, it is rarely used in empirical work. Instead, researchers often appeal to the “theoretically incorrect” but more measurable, average q.

As mentioned, the results of the studies cited are mixed, with the majority based on current and lagged values of average q favorable to the q theory. One study not supportive of q is that of Barro (1990) where he found that stock returns outperformed Dq (change in q, over time) in predicting investment. His possible explanation is that q incorporates stock returns plus a component that is dominated by noise. It is worth noting again that models using lagged q’s incorporate the dynamic structure of q similar to Barro’s Dq. However, as already mentioned, this is not quite the same concept as marginal q. The studies based on marginal q, such as those by Blanchard et al (1993) and Aquino (1999-2000) are not so favorable but the more recent cross sectional study by Dumev et al (2001) shows results somewhat supportive of the q theory.

There is survey evidence that Philippine firms employ rational techniques, in the sense that they are consistent with the objective of maximizing shareholders’ wealth in choosing investment projects. A study by Echanis and Kester (1997-98) surveyed publicly listed firms to determine their use of quantitative techniques in the evaluation of capital expenditures. About 73% or 30 firms of the 41 that responded indicated that they subjected all capital investment proposals to quantitative evaluation techniques. The techniques most commonly cited were the IRR and NPV techniques, which are based on the principle of shareholders’ wealth maximization and can be derived from the present value model of stock prices and equivalently from the q model.

In their study of the U. S. stock market for the period 1959-87, Morck, Shleifer and Vishny concluded that “overall, a fair reading of the evidence is that the stock market is a sometimes faulty predictor of the future,” which does not receive much attention and does not influence aggregate investment.” If this is so, then stock prices do all the necessary adjustments to bring the market into equilibrium. In the Philippines, Baustista (2001), using regime-switching ARCH regression methods on stock market data from 1987-2000, observed that episodes of high stock market volatility are followed by periods of low economic growth.

3.3 Tobin’s q Theory of Investment

3.3.1 Investment Model with Adjustment Costs

The reference for this discussion is Romer (1996). For a representative firm, let its profits be a concave function $\Pi(K(t))$ of its capital stock $K(t)$ at point in time $t$, i.e., $\Pi'(K(t)) > 0$ and $\Pi''(K(t)) < 0$. Let $I(t)$ denote the firm’s investment at time $t$ and assume for simplicity that the depreciation rate is zero.

The key assumption of the q model is that the firm faces a cost of adjusting its capital stock $C(I(t))$ that is a convex function of investment, i.e., $C'(I(t)) > 0$ and $C''(I(t)) > 0$. The firm’s profit at time $t$ is

$$\Pi(K(t)) - I(t)) - C(I(t)).$$

The risk neutral firm’s objective is to maximize the present value of these profits, i.e.,

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2 Macroeconomists, in describing the ability of the stock market to predict business cycles, like to cite the often-quoted remark that “the market has forecast ten of the last five recessions.” James Tobin attributed this remark to Paul Samuelson in his comments on the paper by Merton (1984).

3 Alternatively, the investment rate can be assumed to be net of depreciation cost.
The Hamiltonian of (1) is

\[ H = e^{-rt} \left[ \Pi(K(t)) - i(t) - C(I(t)) \right] + \lambda(t) \left[ \dot{K}(t) - I(t) \right] \]

where \( \lambda(t) \) is the costate variable or shadow price of the state variable \( K(t) \) and \( q(t) = e^{rt} \lambda(t) \).

Differentiating the Hamiltonian with respect to the control variable \( I(t) \) yields the first optimality condition for the maximization problem in (1)

\[ q(t) = 1 + C'(I(t)). \]

Differentiating the Hamiltonian with respect to the state variable \( K(t) \) yields the second optimality condition. Simplifying,

\[ \Pi'(K(t)) = rq(t) - \dot{q}(t). \]

The final condition is the transversality condition

\[ \lim_{t \to \infty} e^{-rt} q(t)K(t) = 0 \]

which means that the firm’s terminal capital holding is zero.

Equations (2) to (4) characterize the representative firm’s behavior under the model. The differential equation in (3) implies that

\[ q(t) = \int_0^\infty e^{-rt} \Pi'(K(t)) dt. \]

Equation (5) states that the value of a unit of capital equals the discounted value of its future marginal products.

The foregoing analysis implies that \( q \) summarizes all information about the future that is relevant to a firm’s investment decision, i.e., \( q \) is a sufficient statistic. Thus, the firm wants to increase its capital stock if \( q \) is high and reduce it if \( q \) is low; it does not need to know anything about the future other than the information that is summarized in \( q \) in order to make this decision (Romer, 1996). Interpreting \( q \) as the market value of a unit of capital for firms with traded shares, \( q \) is also the ratio of the firm’s market value to the replacement cost of its assets. In this form, this ratio is commonly referred to as Tobin’s \( q \).

3.2 Tobin’s \( q \)

The intuition behind Tobin’s \( q \) is provided by Keynes (1936):

“The daily revaluation of the Stock Exchange, though they are primarily made to facilitate transfers of old investment between one individual and another, inevitably exert a decisive influence on the rate of investment. For there is no sense in building up a new enterprise at a cost greater than that at which a similar existing enterprise can be purchased; whilst there is an inducement to spend on a new project that may seem an extravagant sum, if it can be floated off on the Stock Exchange at an immediate profit.”
The alternative derivation of Tobin’s q follows closely that of Tobin (1998). As discussed, Tobin’s q is defined as

\[ q = \frac{MV}{RC}, \]

where, as defined previously, MV is market value and RC is replacement cost. Letting MPK be the net marginal product of capital\(^4\), the return of capital \( r_k \) for a small interval of time \( t \) is

\[ r_k = \frac{\text{MV} \cdot \text{MPK}}{\text{MV}} \]

(3.7)

where \( \frac{\text{MV}}{\text{MV}} = \text{d}(\text{MV})/\text{dt} \). The first term in the right-hand side is the current yield, e.g., earnings or dividend payouts, and the second term represents capital gains or increases in market value of the firm. There is equilibrium in the capital market when the expected return on capital \( E(r_t) \) is equal to the rate of return required by investors \( r \). Taking expectations on (2) conditional on information available in period \( t \)\(^5\) and equating this to \( r \) gives

\[ \overline{r}_t = \frac{E_t(\text{MPK})}{\text{MV}} + \frac{\text{MV}}{\text{MV}}. \]

Rearranging,

\[ \frac{\text{MV}}{\text{MV}} = \overline{r}_t - \frac{E_t(\text{MPK})}{\text{MV}} \]

\[ \text{MV} = \overline{r}_t \cdot \text{MV} - E_t(\text{MPK}). \]

Integrating both sides gives

\[ \frac{\text{MV}}{\text{MV}} = \int_0^t E_t[\text{MPK}(t)] \text{e}^{-rt} \text{dt}. \]

The marginal efficiency of capital \( \text{ir} \) (which is what financial practitioners call the IRR or internal rate of return) is defined to be the discount factor that equates replacement cost to the right hand side of the following equation:

\[ \text{RC} = \int_0^t E_t[\text{MPK}(t)] \text{e}^{-rt} \text{dt}. \]

If MPK is assumed to be constant over time, then from (9) and (10), \( \text{MV} = \text{MPK}/\text{ir} \) and \( \text{RC} = \text{MPK}/\text{ir} \) are obtained. Then, q can be expressed as

\[ q = \frac{\text{MPK}/\text{ir}}{\text{MPK}/\text{ir}} = \frac{\text{ir}}{\overline{r}_t}. \]

The discrete analog of equation (9) is provided in chapters on valuation of a going concern in most textbooks in corporate finance, for example Brealey and Myers (1996), in terms of free cash flows.

\(^4\) Tobin (1998) used gross marginal product of capital and deducted \( \delta \), the depreciation rate, from the right-hand side of equation (3.6). Here, the net marginal product of capital after depreciation is used to be consistent with current financial usage. The assumption is that the depreciation charges are flowed back to maintain indefinitely the productivity of capital and are therefore not free to be distributed to shareholders.

\(^5\) \( E_t[\cdot] = E[\cdot | \Omega_t] \) where \( \Omega_t \) is the information set at time \( t \).
where $E_t[FCF_t]$ is the firm’s expected free cash flows from operations available for debt servicing and dividend payouts and $\tilde{R} = \exp(\bar{r}) - 1$ is the discrete equivalence of the continuously compounded rate of return $\bar{r}$ required by investors. $\tilde{R}$ or $\bar{r}$ is usually interpreted as the firm’s average cost of capital. Note that

$$\text{MV} = \sum_{t=1}^{\infty} \frac{E_t[FCF_t]}{(1 + \tilde{R})^t}$$

where $E_t[MV_m]$ is the expected market value at end of period $m$ based on information known at time $t$. This expression is particularly relevant in the Philippine setting where returns from current dividends are not very significant relative to expected capital gains.

### 3.2 The Present Value Model

The net simple return on a stock is defined as

$$R_t = \frac{P_t + D_t}{P_{t-1}} - 1$$

where $P_t$ denotes the ex-dividend price of a share of stock at the end of period $t$. Assuming that investors have rational expectations and that the expected stock return $E(R_t)$ is equal to a constant $R$, equation (14) relating current stock price to the next period’s expected price and dividend can be rearranged as (Cuthberston, 1996):

$$P_t = E_t[\frac{P_{t+1} + D_{t+1}}{1 + R}]$$

Solving this forward and using the law of iterated expectations, the following is obtained

$$P_t = \sum_{i=1}^{\infty} \frac{E_t[D_{i+1}]}{(1 + R)^i} + E_t[\frac{P_{t+m}}{(1 + R)^m}]$$

Multiply this by the number of outstanding shares gives $MC_t$, the total market capitalization of the firm’s stocks. Let total liabilities be the discounted value of its debt service payments

$$TL_t = \sum_{i=1}^{\infty} \frac{DS_{i+1}}{(1 + i)^i} + \frac{TL_{i+1}}{(1 + i)^m}$$

Adding to this the results of equation (16) multiplied by the number of outstanding shares and noting that $E_t[D_{i+1}] + TL_{t+i} = E_t[FCF_{i+1}]$, equation (13) is obtained and restated below.

$$\text{MV} = \sum_{t=1}^{\infty} \frac{E_t[FCF_t]}{(1 + \tilde{R})^t} + E_t[\frac{MV_m}{(1 + \tilde{R})^m}]$$

where $\tilde{R}$ is an average cost of capital between $i$ and $R$. Thus, Tobin’s $q$ and the present value model are conceptually the same. Equations (16) and (18) are also called the fundamental valuation formulae for the firm’s stock and total claims on its assets, respectively.

### 3.3 Investment Appraisal Application

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6 The law of iterated expectations states that $E[E[X|\Omega_{t-1}]|\Omega_t] = E[X|\Omega_t]$. 
The discrete analog of equation (10) can be found in chapters in capital budgeting in corporate finance textbooks as decision rules on whether to accept or reject an investment proposal in accordance with the principle of rationality. There are two most commonly recommended approaches: the IRR method and the net present value or NPV method. The IRR method is closest to equation (10) above. It finds the value ir that equates the sum of the discounted future income or cash flows (CF) over the life of the investment to the initial investment I0. Formally, ir is found from

\[ I_0 = \sum_{t=1}^{n} \frac{CF_t}{(1 + ir)^t}. \]

If ir is greater than a pre-selected hurdle rate \( \tilde{r} \), which may be the average cost of capital \( \tilde{R} \) or \( \tilde{r} \) mentioned above, the investment proposal is acceptable. Otherwise, it is not. Thus, this is functionally equivalent to using the marginal q concept as the decision rule can be restated as accept investment proposal if the ratio IRR/ \( \tilde{R} \) or IRR/\( \tilde{r} \) is greater than one, otherwise, do not. All investment proposals passing this hurdle will be accepted such that theoretically average q will tend to unity.

The NPV approach computes the net present value (NPV) of the future income or cash flows (CF) over the life of the investment, i.e.,

\[ \text{NPV} = \sum_{t=1}^{n} \frac{CF_t}{(1 + r)^t}. \]

The NPV is then compared to the initial investment I0. If it is greater, accept the investment proposal, otherwise, don’t. Sometimes this approach is extended to computing a NPV index = NPV/ I0. Again, if the index is greater than one, the investment proposal is acceptable. Otherwise, it is not.

Note the similarity between the ratio IRR/ \( \tilde{R} \) or IRR/\( \tilde{r} \) and the NPV index. While both are functionally equivalent to q, they do not normally yield the same number. Nevertheless, under both approaches, average q tends to unity as long as all investment proposals passing the hurdle are implemented. In actual application, the IRR approach is preferred by financial analysts because, unlike in the NPV approach, one is not compelled to exactly specify \( \tilde{R} \) or \( \tilde{r} \). The financial analyst normally just evaluates the IRR obtained whether it is “high enough” as compared to an unspecified benchmark.

### 2.4 Average vs. Marginal q

The issue of which measure of q is the relevant stimulus to investment is by no means clear-cut as the previous discussion implies. Fisher and Merton (1988) argued that investment decisions should be based on average q which is equated with the stock market’s valuation of the firm’s assets. The argument is that if the market is willing to accept a lower rate of return (higher average q) for the firm’s common stocks, then the firm should issue shares and invest until the marginal product of capital is equal to that rate of return. The logic of their arguments goes like this. Suppose that investment has proceeded to the point that marginal q is equal to one. If average q is still greater than one, then it pays existing shareholders for the firm to issue more shares and invest the proceeds until average q is driven down to one. At this point, marginal q would also have gone down lower than one. Blanchard, Rhee and Summers (1993) showed the flaw in this argument from the viewpoint of Pareto efficiency. Essentially, their counter-argument is that the added benefits to existing shareholders constitute transfers from new shareholders. Rational decision-making means that maximizing the wealth of shareholders, both new and old, is the appropriate objective of management. If the proceeds of the new issuance of shares are
invested in projects with marginal q’s lower than one (equivalently, with negative net present values), the set of shareholders as a whole will be worse off.

3.4 Data and Methodology

The market capitalization data used in the analysis came from the published monthly reports of the Philippine Stock Exchange from 1994 and before that from the Makati Stock Exchange. Financial data came from the annual compilations made by Philippine Business Profiles & Perspectives, Inc. and Business World. The individual companies covered are those comprising the Philippine Stock Exchange Index or Phisix with at least five years of available financial data. Thus, only 26 of the 30 companies comprising the Phisix are included in this investigation. Additional financial data, particularly on the holdings of the five major shareholders of companies, are from the Philippine Stock Exchange publication, the 2001 Corporate Handbook. Inaccuracies in the financial data used due to differences in reporting and accounting practices may be major limitations to the study. However, this will not be specifically addressed in this study.

One main issue in calculating average and marginal q at the firm level is the absence of replacement cost as well as depreciation data for fixed assets in publicly available summarized financial data. Thus, the estimation procedures for this study were based on the method used by Aquino (2000), a variant of the procedures used by Lang et al. (1989) which in turn were based on earlier work by Lindenberg and Ross (1981) and Smirlock et al. (1984). The replacement cost of the firm’s assets is computed as \( RC_t = CA_t + FA_t \) where \( CA_t \) is the firm’s current assets at the end of period \( t \) valued at book value. \( FA_t \) is the replacement cost of the firm’s fixed assets at the end of period \( t \), denoted, is computed as:

\[
FA_t = FA_{t-1} \left[ \frac{1 + \phi_t}{1 + \delta_t} \right] + FI_t
\]

where \( \phi_t \) is the rate of growth in capital goods prices estimated by the NEDA GDP price deflator for fixed capital formation, \( \delta_t \) is the depreciation rate which, following Smirlock et al. (1984) is set constant at 5%, and \( FI_t \) is the period \( t \) investment in fixed assets of the firm estimated as the growth in the net book value of fixed assets and adding back estimated depreciation. Let \( BV_t \) denote the book value of total fixed assets at the end of year \( t \). Then, equation (21) is solved forward from the earliest year financial data are available (Year 0) where \( FA_0 \) is set equal to the starting book value \( BV_0 \) to obtain:

\[
FA_t = BV_t + \sum_{i=1}^{t-1} BV_i \left[ \frac{\phi_{i+1} + 2\delta - \delta^2}{1 - \delta} \right] \prod_{j=1}^{t} \left[ \frac{1 + \phi_j}{1 - \delta} \right].
\]

Equation (22) shows that the deviation of the replacement cost of fixed assets of the firm from the book value depends (1) positively on the amount of fixed assets acquired in the past, (2) positively on the growth rate in capital goods, and (3) negatively on the depreciation rate.

The main hypothesis to be tested is whether Tobin’s q has any effect on the firm’s investment decision. Empirically, the Pareto efficiency hypothesis is actually a joint hypothesis that the market is efficient, that the fundamental valuation equations (16) and (18) are the correct valuation models for the firm, and that firms behave rationally in making investment, i.e., expansion or divestment, decisions? Or, in statistical terms, the null hypothesis is that measures of Tobin’s q exhibit no explanatory power on firms’ investment decision-making, i.e., they do not make the implied calculations and follow the rule that it pays to invest whenever the percentage yield or internal rate of return exceeds the average cost of capital implied by interest rates and stock prices. On the basis of the discussions in Section 3, it is reasonable to hypothesize a direct relationship between a firm’s investment outlays and the value of marginal q. Similar to Hayashi’s (1982) aggregate formulation, the following is postulated at the firm level:
\[
\frac{I_t}{TA_{t-1}} = \alpha + \beta q
\]

where \(I_t\) is the firm's investment outlay in period \(t\), \(TA_{t-1}\) is the previous year's total assets, and \(q\) is its marginal \(q\). The ratio \(I_t/TA_{t-1}\) can also be interpreted as the firm's rate of investment. For the cross section regression, \(I_t/TA_{t-1}\) can be approximated as \(dTA_t/TA_t\) or \(d(lnTA_t)\). Hence, the following equation is set out:

\[
(24) \quad TA_t = a_0*exp\{b_0t\},
\]

where \(b_0\) now represents the estimate of \(I/TA\) for a particular firm.

In the cross section analysis, average \(q\) is computed as the ratio of the firm's market value to its replacement cost as estimated using the procedures mentioned above. In estimating and testing (23) using marginal \(q\), which is not directly measurable, a two-pass procedure that originated with Fama and MacBeth (1973) will be used. This procedure is commonly used for tests of hypothesis of the capital asset pricing model (CAPM) will be used. The first pass is to estimate marginal \(q\) and \(d(lnTA_t) = b_0\) using time series financial data by firm in (24). The second pass is to run the cross section regression equation (23). This procedure is similar to those in Aquino (1999-2000) and Dumev, Morck and Yeung (2001) except for the specification of the equation fitted to the time series financial data.

### 5 Firm-level Investment and Tobin's q

#### 5.1 Investment Rate vs. Average \(q\)

One of the main problems in this study is the construction of measures of marginal \(q\) for individual companies from available data. Many past studies use average \(q\), for example, von Furstenberg (1977), or proxies in place of the unobserved marginal \(q\). Bosworth (1975) reported a study where an eight-quarter weighted lag structure of average \(q\)'s was used in place of direct measures of marginal \(q\). Blanchard, Rhee and Summers (1993) constructed direct estimates of marginal \(q\) by predicting future earnings and discount rates using current and lagged values of the profit rate, average \(q\) and the dividend-price ratio. After running their regressions on investments and other variables, they concluded that their proxy estimate may not, after all, be right and that the profit rate itself may be a more appropriate measure to use in their analysis. Morck, Shleifer and Vishny (1990) used stock returns as proxy for marginal \(q\). Reservations have been expressed, for example by Caballero (1997) and Cooper and Ejarque (2001), on the use of average \(q\) with and without lagged values in investment regressions especially if the requirements for their equivalence (see following discussion) are not met (or even tested).

Hayashi (1982) showed that under certain conditions, the values of average \(q\) and marginal \(q\) are equal. These conditions are that the firm is a price-taker and that its production function and installation function are linearly homogeneous. Hence, if this equivalence is found to be plausible, average \(q\) can be used in the analysis without worrying about estimating marginal \(q\). However, a practical empirical implementation is needed to validate this result. To test statistically the hypothesis that average \(q\) is equal to marginal \(q\) is equivalent to testing that average \(q\) is invariant to scale of operations. Hence, average \(q\) can be regressed against replacement cost \(RC\), i.e., for each firm

\[
q_{t}^{ave} = \beta_0 + \beta_1 RC_t.
\]

Marginal \(q\) is derived from equation (25) as follows:

\[
q_{t}^{marg} = \frac{dMV_t}{dRC_t} = \beta_0 + 2\beta_1 RC_t.
\]

Equations (25) and (26) imply that \(q_{t}^{ave} = q_{t}^{marg}\) only if \(\beta_1 = 0\). Then, \(q_{t}^{ave} = q_{t}^{marg} = \beta_0\).
The test is run on 26\(^7\) of the 30 firms comprising the Phisix (see Tables 2.1 and 2.2 for the list of firms and their respective shares in market capitalization and transaction value) covering the period 1994-1999. The firms excluded are for reasons of lack of continuous time series financial data. However, they represent only 0.75% of the total market capitalization of the index firms. In 22 of the 26 firms, the condition \( \beta_1 = 0 \) is rejected at higher than 90% confidence level (11 are rejected at 95% and 5 are rejected at 99% confidence level). In 24 of the 26 firms, the sign of the slope parameter, is negative meaning that average q goes down as scale of operations increases. This is indicative of decreasing returns to scale which, if valid, does not support one of Hayashi’s conditions. As an aside, one firm with positive slope coefficients is a utility company while the other is a holding firm for utility companies. As an additional test to allow for heteroscedasticity, a cross sectional weighted least squares regression is run on equation (24) with the average replacement cost of the firms as the regressor during the period covered. The results are no different as can be seen in Chart 1.

![Chart 1 – Average q vs. Replacement Cost by Firm](image)

The t-test rejects the null hypothesis that the slope coefficient is zero (with p-value of 0.0007). The negative slope indicates marginal q declining with scale consistent with a neoclassical production function. The apparent presence of heteroscedasticity in the data is noted; hence the use of weighted least squares with the reciprocal of replacement cost as weight. The fit is quite good with \( R^2 = 0.84 \). These results, plus the fact that the industries to which the sample firms belong consist only of a few players and that the firms themselves are large, do not render plausible an assumption that these firms are price-takers.

Based on the above result, average q cannot serve as surrogate for marginal q. Nevertheless, the relationship in (23) using average q is tested to verify instead the view of Fischer and Merton (1984) that average q and not marginal q is the relevant variable for investment decision-making. The result of the regression indicates a positive relationship between

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\(^7\) PCI Bank merged with Equitable Bank in 1999 with Equitable-PCI Bank as the surviving entity. Only data pertaining to PCI Bank before the merger are included in the regressions.
investment and average q but the $\beta$ coefficient is not found statistically significant. $R^2$ is only 0.0073 and the p-value for the slope parameter is 0.6779.

3.5.2 Investment Rate vs. Marginal q

Based on the previous results, there is no basis to use average q as surrogate for marginal q. In this section, time series procedures will be used to estimate marginal q by firm. Each firm’s marginal q is estimated from time series data as follows:

$$MV_t = a + b RC_t$$

where $b =$ marginal q can be verified by taking the derivative of (27) with respect to $RC_t$.

In applying equation (27) to the data, 8 out of the 26 firms show negative values of marginal q suggesting that the market believes additional investments by these firms will yield negative net present values (see Table 2). Only four firms have a marginal q more than the indicated threshold value of one. However, investment rates have been positive for all the 26 companies. Running regression equation (23) results in a positive relationship between investment rate and marginal q with $R^2 = 0.0060$ and a p-value on the slope coefficient of 0.6877. This result is no better than the result using average q.

The above results already tell us that Tobin’s q has no explanatory power over firm investment decisions. The possibility that this poor performance is a result of measurement error cannot be discounted. However, given the results in Chapter Two, lack of market efficiency is the a more likely cause. Other possible causes are discussed in the next section. Another possibility is that market fundamentals may have changed over time and, assuming market efficiency, this fact has been incorporated in the market’s valuation of the firm’s existing operations. To allow

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8 Since market perception of marginal projects is involved, negative marginal q’s are not implausible. For example, the market may perceive a firm’s new project to have negative marginal present values because it is likely to lose money, or that it will cannibalize or have a negative impact on the firm’s existing operations. e.g., two fast food restaurants located too closely with each other.
Table 2 – Estimates of Firm Average and Marginal q’s

<table>
<thead>
<tr>
<th>Code</th>
<th>Average q</th>
<th>Marginal q</th>
<th>t-stat</th>
<th>p-value</th>
<th>R²</th>
<th>Marginal q</th>
<th>t-stat</th>
<th>p-value</th>
<th>R²</th>
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<td>-1.5756</td>
<td>-1.8498</td>
<td>0.1380</td>
<td>0.4610</td>
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<td>1.3898</td>
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</table>

Note: The codes are the Philippine Stock Exchange codes for the different stocks (see Aquino, 2002).
for this possibility, equation (27) is modified as follows:

$$MV_t = a + b \cdot RC_t + c \cdot S_t$$

where $S_t$ is the end-of-year nominal value of the Philippine Stock Exchange index (Phisix). The parameter $c$ is analogous to the market beta in CAPM. This is to remove the influence of changes in the market valuation of the firm’s existing operations that is attributable to changed market fundamentals on the estimate of $b$ or marginal q. The estimated marginal q’s following this procedure are also in Table 2. Although now, only 4 of the 26 firms show negative marginal q’s, the regression results are even worse than before. Running regression equation (23) results in a positive relationship between investment rate and marginal q with $R^2 = 0.0002$ and a p-value on the slope coefficient of 0.9417.

6 Discussion of Results

The results of the cross sectional regression of investment growth against firm marginal q’s (or even average q’s) has not been very supportive of Tobin’s q as a theory of investment. Without discounting the possible role of measurement errors, this section looks at other possible explanations for these poor results. These include financial constraints, informational inefficiency of the stock market, and agency problem because of conflict of interests between controlling shareholders and ordinary investors. The effect of financial constraints is discussed first.

Financial constraints may be important dampening factors for investment as suggested by the results of Fazzari et al (1988), Kaplan and Zingales (1995) and Aquino (1999-2000). To verify this for the firms covered in this study, investment growth is regressed against marginal q and two measures of financial constraints, i.e., debt-equity ratio and fixed assets to total assets ratio. A high debt-equity ratio is supposed to limit a firm’s capability to finance new projects. At the same time, a high fixed assets to total asset ratio implies high investment requirements for projects that cannot easily be financed either through debt or additional equity. The regression, however, yields statistically insignificant results. The coefficients of marginal q and debt-equity ratio, although both positive, have p-values of only 0.8069 and 0.4739. The coefficient of fixed assets to total assets ratio is negative and a p-value of 0.4812. These results indicate that financial constraints are not a limiting factor to investment for the firms and the period (1994-1999) covered. This conclusion seems plausible as the firms covered are large firms controlled by large business groups (see Saldaña, 2001 and Philippine Stock Exchange, 2001) and are not likely to be subject to major financial constraints.

As mentioned earlier, the Pareto efficiency hypothesis is actually a joint hypothesis that the market is efficient, that the fundamental valuation equations (16) and (18) are the correct valuation models for the firm, and that firms behave rationally in making investment, i.e., expansion or divestment, decisions. By rational investment decision-making, the firms follow the rule of investing whenever the percentage yield or internal rate of return exceeds the average cost of capital implied by interest rates and stock prices. This implies that firms act to maximize shareholders’ wealth.

The results of the previous essay suggest that the local stock market is only at best weak-form efficient. Thus, one obvious candidate explanation for the empirical failure of the q model is that the stock market is informationally inefficient such that prices do not provide the right signals for investment decision-making or that the signal-to-noise ratio is very low. This is suggestive of the results of Barro (1990) where he found that stock returns outperformed q in predicting investment. His explanation is that q possibly incorporates stock return plus a component that is dominated by noise. In this case, stock return itself may be dominated by noise thus further distorting the signals. This explanation sounds plausible but not altogether satisfying as the stock market must at least be conveying some information to firm management about the company’s cost of equity and the market’s valuation of its investment prospects. The relevant concept in the latter is marginal q while average q is the one relevant in the former case. Fischer and Merton (1984) argued that firms should exploit high market valuations of their stocks and
undertake investments when equity financing costs are low, i.e., high average q’s. If the market is willing to accept a lower rate of return (higher average q) for a firm’s common stocks, it pays existing shareholders for the firm to issue more shares and rearrange the capital structure until average q is driven down to one. With additional investments, marginal q would also have gone down lower than one or even negative. However, such a financial strategy is disadvantageous to new shareholders. In effect, the benefits to old shareholders constitute transfers from incoming shareholders. If the market is efficient, this situation will not occur because average q would have adjusted quickly to reflect fundamental values by operation of market forces. Thus, even if firms are rational, high average or marginal q need not be associated with higher investment within the same firm as the statistical evidence suggests.

As Haugen (1995) pointed out, investments are not limited to the left-hand side of the balance sheet. Management can also improve the welfare of existing shareholders by “investing” on the right-hand side of the balance sheet, i.e., rearranging the capital structure. When markets are not efficient, the firm’s cost of capital can be lowered by issuing say, lower cost equity to replace higher cost debt, or vice-versa. In periods of high average q (and therefore lower cost of equity capital), firms may also rely more on equity than on debt to finance new investments. Issuing stock dividends to existing shareholders, who can then sell the shares in the stock market, is also one way for firms to compensate shareholders without paying out cash. Existing shareholders may take advantage of high stock prices to liquidate part of their holdings to finance their own other investment prospects. If the firm is listed, their sales of shares will even be exempt from capital gains taxation. It is worth noting that fourteen of the 30 firms that constitute the Phisix were listed only and made initial public offerings (IPOs) during 1994-1997, the period of high stock prices and high average q. With low marginal q’s, average q has been on the downtrend since then. As already mentioned, the three-year average q for 1994-1996 was 2.34 for the firms studied. In 1997-1999 it was 1.27. Total assets for all firms have been increasing while most firms’ estimated marginal q’s are less than one. Thus, the conjecture that stock markets signals are largely ignored by decision-makers does not seem plausible. However, the effect is not on investment alone but also on the capital structure and the relevant concept is average, not just marginal, q.

In the foregoing explanation, the interests of existing and new shareholders are divergent because of market inefficiency. Firms acting rationally will tend to benefit existing shareholders at the expense of new shareholders. However, even if the market is efficient, an alternative explanation for the investment behavior of firms can be given in terms of the inherent conflict of interests between controlling shareholders and ordinary investors. Saldaña (2001) stated that, as in many other Asian countries, controlling shareholders in the Philippines usually exercise their corporate control through the setting up of business groups, which are usually controlled by holding companies. Holding companies enable controlling shareholders to collectively own shares of other companies in a business group and to centralize the group's management. Although there are operational benefits, this arrangement also makes it easier for controlling shareholders to expropriate interests of minority shareholders. Saldaña notes that such expropriation is due to gaps between control rights and cash flow rights that pyramiding structures of business groups centered on holding companies create. Cash flow rights refer to the relative amount that one investor group receives when cash or liquidating dividends are declared by a firm. Control rights in theory may refer to the voting percentage or the number of members of the board controlled by that group. When control rights exceed cash flow rights, large shareholders can use their control to transfer wealth from a company in a business group where they have low cash flow rights to another where they have high cash flow rights, e.g., from a minority-controlled to a majority-owned subsidiary. For example, the controlling shareholders are more likely to implement high NPV or high marginal q projects in their majority-owned company than in their minority-controlled company. If this hypothesis is correct, then one would expect a firm’s investments to vary inversely with the gap between control rights of the controlling holding company and its cash flow rights. In the firms covered where the control rights can
effectively be considered as 100%, this translates into a positive relationship between firm investments and cash flow rights of controlling shareholders. The theoretical basis for this claim is provided by Leland and Pyle (1977).

The Leland-Pyle model is a two-period model which assumes the following:

- an entrepreneur has an investment project with required investment $K$ and future return $\mu + \tilde{x}$ where $\mu$ is the expected end-of-period value of the project and $\tilde{x}$ is a random variable with mean zero and variance $\sigma^2$.
- the entrepreneur plans to hold a fraction $\alpha$ of the firm’s equity and raise the remainder of the requirement $K$ from other non-controlling investors.
- the entrepreneur and the firm can both borrow at the same riskless rate.
- the entrepreneur has more information about the project than the outside investors. In particular, the entrepreneur knows $\mu$. Uninformed investors will have to infer in equilibrium the true $\mu$ through a function of $\alpha$, i.e., $\mu(\alpha)$. Thus, $\alpha$ is used as a signaling device in this environment of asymmetric information.
- An individual’s demand for a financial asset is normal. This is defined to mean that, in a portfolio choice situation without signaling, the individual will always demand a larger amount of that asset when its price falls.
- The entrepreneur is a utility maximizer where his utility is a monotonically increasing function of wealth. His end-of-period wealth is in turn a function of $\mu$, $\alpha$ and the end-of-period price of the company stock.

Under these assumptions, Leland and Pyle show that $\mu(\alpha)$ is an increasing function of $\alpha$. Thus, entrepreneurs associated with good projects are identified with their high values of $\alpha$. In equilibrium, higher firm investments are identified with the controlling entrepreneur retaining a high proportion $\alpha$ of the firm’s equity. Applying these concepts to our data set, the entrepreneurs with inside information are the controlling shareholders. The proportion $\alpha$ representing cash flow rights of the entrepreneur is measured by the percentage of equity held by the five largest shareholders based on the 2001 Corporate Handbook published by the Philippine Stock Exchange. The assumptions listed above seem plausible for the firms considered. In particular, the assumption about the entrepreneur and the firm he controls being able to borrow at the same riskless rate is not considered restrictive because in most, if not all, cases, the controlling shareholders are larger firms or business groups with at least equal access to the credit market as the firms being controlled. If the hypothesis is correct, then investment will be directly associated with the cash flow rights $\alpha$ of the controlling shareholders. The result of regressing investment growth against marginal $q$ (computed using regression equation (27)) and $\alpha$ is:

$$IG_i = 0.10121 - 0.01815q_i + 0.00223\alpha_i$$

where $IG_i$ is the firm $i$’s investment rate, $q_i$ is its marginal $q$ and $\alpha_i$ is the percent equity held by the five largest shareholders. $R^2$ is 0.1397. The figures in parenthesis are the p-values of the coefficients. Based on this, it is seen that the coefficient for $\alpha$ is statistically significant. However, the coefficient for $q$ is not statistically different from zero. Thus, the hypothesis that investment growth is related positively to the cash flow rights of the controlling shareholders is accepted, offering a plausible alternative explanation for investment in place of $q$ because of the conflict of interests between controlling shareholders and uninformed investors.

7 Concluding Remarks

The results of the analysis in this essay are summarized below.
The econometric evidence resulting from the cross section analysis conducted in this essay supports the view that the stock market is not allocationally or Pareto efficient. The hypothesis that the measured marginal $q$ is positively related to investment at the firm level is not accepted.

Without discounting the possible role of measurement error, the main explanations for the unfavorable results offered are market informational inefficiency and the inherent conflict of interests between ordinary investors and controlling shareholders. When the market is not efficient, for example, proceeds from new equity issues (IPOs) such as those made during the boom period of 1994-97 when average $q$’s were high (and equity cost of capital is low) can be used to lower the firm’s average cost of capital and not necessarily to fund new investments. If controlling shareholders (and existing minority shareholders) are able to liquidate part of their holdings at high prices while retaining control, then this constitutes wealth transfers from new to old shareholders at no cost to the controlling shareholders.

Investments are also found to be related positively with the ownership percentage of firms’ controlling shareholders or shareholder groups. This indicates that, at least for the period covered by the study, investments are made on the basis of favorable information known only to the controlling group. This information, however, is not immediately known to ordinary investors and therefore only incorporated into prices and marginal $q$ with some lag. Thus, even if the market is relatively efficient (say, with respect to prices and all publicly known information), Tobin’s $q$ as a model of investment can still fail empirically because the firm’s investment behavior is subject to the inherent conflict of interests between controlling shareholders and ordinary investors.
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