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AN ANALYSIS OF PREFERRED EQUITY
REDEMPTION CUMULATIVE STOCK

DISSERTATION

Presented to the Graduate Council of the
University of North Texas in Partial
Fulfilment of the Requirements

For the Degree of

DOCTOR OF PHILOSOPHY

By

Hansong Pu, B.S., M.S., M.B.A.

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This dissertation examines whether Percs, Preferred Equity Redemption Cumulative Stocks, are properly priced regarding to the relevant securities, such as the underlying common stock, the long-term call option of the stock, and so on. Test results indicate that Percs were overpriced with respect to the equivalent packages composed of the relevant securities. Further tests on arbitrage restrictions show that transaction costs would prevent arbitrage profits.

This dissertation also examines the market reactions to Percs offerings. Test results reveal that the market reactions to the announcement of Percs offering and the actual issuance are both significantly negative. Compared to the market reaction on common stock offering announcement, the market reaction on Percs offering announcement is weaker.

The overpricing of Percs and the weaker reaction of the market suggest that Percs may have advantages in transaction costs, taxes and some corporate finance issues.

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CHAPTER I

INTRODUCTION

Purpose

This dissertation is composed of two parts. The first part examines whether Percs, a hybrid security, is properly priced with respect to the relevant securities, such as the underlying common stock, the long-term option, and so on. As price imparity is found between Percs and the equivalent package made up of the relevant securities, a further investigation is conducted on the possible violation of market efficiency, i.e., whether the price imparity generates any arbitrage opportunities, and why the imparity exists.

The second part investigates the impact of Percs offerings on the prices of common stocks. It is an event study on Percs offerings. The impact of Percs offerings is compared to that of common stock offerings. The outcome would add new findings to the existing body of evidence about the market reactions upon corporate equity offerings.

The results of this research may give an assessment of Percs, such as whether the hybrid security possesses any advantages, what it can contribute to investors and

companies, whether it consists of anything that is really constructive and innovative, etc.

Description of Percs

The full name of Percs is Preferred Equity Redemption Cumulative Stock. It is also called Mandatory Conversion Premium Dividend Preferred Stock. As the name declares, Percs is a preferred stock. Like other preferred stocks, it receives fixed dividends, which are cumulative and senior to the dividends of the common stock. The dividends of Percs are significantly higher than the dividends of the common stock. Unlike other preferred stocks, Percs is mandatorily convertible to common stock. The date of mandatory conversion is about three years after the Percs is issued. The conversion price on that date, which is set at the time of offering, is called "cap". It is normally 30 percent to 45 percent above the closing price of the common stock on the day previous to the issue date of Percs. If the common stock price is lower or equal to the cap on the date of mandatory conversion, a share of Percs is converted to a share of common stock. Otherwise, it is converted to a fraction of a common share, with the value of that fraction equal to the cap. The capital gain of Percs is thus capped. Percs is issued at the closing price of the common stock on the previous day. The cap is compensated by the extra

dividends above the common dividends through the three-year life of the Percs.

The issuer is allowed to call its Percs any time before the mandatory conversion date. During the period from the issuance of the Percs to the date normally two months before the mandatory conversion, the call price of the Percs declines every day and equals the cap plus the total extra dividends to be paid in the remaining life. In the last two months, the call price keeps constant at the cap. In addition to the call price, the issuer needs to pay the accrued and the unpaid, if there are any, dividends on the date of the conversion, no matter whether the conversion is premature or mature.

Since Percs are mandatorily convertible to common stocks, they are graded by rating agencies, like Standard & Poor's, as full-credit equity. The Percs issued by Citicorp, the only banking firm that has issued Percs so far, is treated by the Federal Reserve Board as Tier 1 capital, which by definition includes only common stock and perpetual preferred stock.

Percs is designed and trademarked by Morgan Stanley. By the end of 1992, sixteen companies, most with Morgan Stanley as the sole-manager or the lead-manager of underwriting, have issued Percs. The sixteen companies are listed in Table 1. Except Avon's Percs, which has already

been converted to common stock, all the other fifteen Percs are being listed at the exchanges where their underlying common stocks are listed.

TABLE 1
A LIST OF PERCS

Company	Issue Date	Mandatory Conversion date	Amount (million)
Avon	Jun. 3, 1988	May 5, 1991	\$ 438
General Motors	Jun. 26, 1991	Jul. 1, 1994	\$ 641
K-Mart	Aug. 16, 1991	Sep. 15, 1994	\$1,012
Texas Instruments	Sep. 11, 1991	Nov. 01, 1994	\$ 306
Broad Inc. (SunAmerica)	Oct. 10, 1991	Oct. 15, 1994	\$ 78
RJR Nabisco	Nov. 1, 1991	Nov. 15, 1994	\$2,025
AON Corp.	Nov. 14, 1991	Dec. 1, 1994	\$ 110
Tenneco	Dec. 17, 1991	Dec. 31, 1994	\$ 516
Olin Corp.	Jan. 14, 1992	Mar. 1, 1995	\$ 100
Boise Cascade	Jan. 21, 1992	Jan. 15, 1995	\$ 197
Tandy Corp.	Feb. 14, 1992	Apr. 15, 1995	\$ 443
Sears Roebuck	Feb. 20, 1992	Apr. 1, 1995	\$1,075
Consolidated Freightway	Mar. 11, 1992	Mar. 15, 1995	\$ 106
Westinghouse	Jun. 3, 1992	Sep. 1, 1995	\$ 559
Chiquita	Oct. 30, 1992	Sep. 7, 1995	\$ 81
Citicorp	Oct. 15, 1992	Nov. 30, 1995	\$1,000

Percs was quite successful in 1991 and 1992, during which the security ballooned into an \$8 billion market. However, only one firm, SunAmerica, which is the new name of Broad, has issued Percs in 1993 with volume of \$160 million. It seems that Percs has started to lose its attractiveness.

As the future of Percs appears uncertain, a Percs-like security emerges. It is called Decs, an abbreviation of Dividend Enhanced Convertible Stock.

Decs is designed by Salomon Brothers. As Percs, Decs is issued at the price of the underlying common and mandatorily convertible to the common stock. The date of mandatory conversion is four years, instead of three years, from the issue date. The structural difference between Decs and Percs is that Decs does not have an absolute cap on the upside potential. A share of Decs will convert to a share of common stock if the common price is below the initial level at which the Decs is issued. It will convert to a fraction of the common if the common price is above the initial level. The size of the fraction is inversely connected to the common price until it hits a bottom, beyond which it keeps constant. Thus, the buyers of Decs give away part of the potential in appreciation but their participation with the common is unlimited. The surrendered appreciation potential is compensated by extra dividends. Whereas Percs represents a combination of a long position in common and a short position in call option, Decs represents a long position in common coupled with a spread.

The first Decs was issued by MascoTech, an auto parts manufacturer, in last June. Initially, MascoTech offered 10 million shares of Decs at \$20. The deal was doubled in

size after Salomon Brothers received orders totaling nearly \$400 million.

It can hardly be predicted whether the new hybrid, Decs, will balloon into a multi-billion market in the near future as Percs did previously. It would be more likely that Percs-like hybrids, in a broad sense, various kinds of common-option combinations, will play a role in the equity market.

CHAPTER II

LITERATURE REVIEW

Articles on Percs

Most articles on Percs are published in newspapers or practice-oriented journals, such as The Wall Street Journal, Barron's, Investment Dealers' Digest, Business Week, etc. In addition to reports on the current developments and characteristic descriptions of Percs, those articles introduced various opinions on the advantages of the hybrid security.

In a talk with Tom Pratt (December 2, 1991), the two major architects of Percs at Morgan Stanley, Pandit and Freeman, expressed their own ideas about the security. Freeman considered Percs an efficient way for investors to do buy-write strategies. "It's like one-stop shopping -- a publicly traded, liquid instrument with a built-in buy-write." Pandit attributed their success to their awareness of the "big appetite" for buy-writes with blue chip stocks. The target they suggested for Percs is "any equity manager who's looking to enhance the current income on his portfolio and scale back its risk profile". To companies, as Pandit recommended, Percs provides an alternative way to raise full-credit equity. "The biggest thing that got this thing

(Percs) going was that issuers needed equity," he recalled. "As people started considering alternatives, we had one more alternative --- with a favorable rating agency treatment."

A number of authors proposed that Percs might help companies raise badly-needed equity at the time they are reluctant to issue common stocks.

Emmett Harty (July-August 1992), President of a derivative consulting firm in Connecticut, writes,

"Percs are therefore the vehicle of choice for companies that believe their common stock will rise. ... Percs allow companies to access the equity market even when they believe their stock is too low."

In an article on Barron's, Andrew Barry (March 2, 1992) summarizes the similarities among those Percs issuers.

"Besides their gargantuan size and name recognition, most Percs issuers also have in common a need to raise equity. And for the most part, they've been cyclical companies with depressed stock prices. ... Corporate executives love Percs because the securities appeal directly to their conviction that their common shares are undervalued. Unlike other forms of equity, Percs offer clear financial benefit to companies whose common shares rise sharply."

Stanley Block (November 1992), a finance professor at Texas Christian University, gives a similar scenario.

"Percs is frequently issued by corporations that feel their stock is undervalued. ... These firms, rightly or wrongly, are betting ... that the stock will be higher than the termination value so that they will be able to issue less than one share of common stock for a Percs."

Such scenarios can go even further. If companies tend to issue Percs when their common stocks are undervalued,

they would like to call Percs when their common stocks are overvalued, since they have the right to call their Percs any time before the mandatory conversion date. "... the perfect time to call one (Percs) prematurely would be when the underlying common stock has peaked" (Harty, July-August 1992).

In the previous scenarios, Percs was described as an instrument that would help companies to take advantage of their inside information. The assumption is that investors are on the unfavorable side of the information asymmetry. However, as Barry (March 2, 1992) mentioned, they might be aware of their own situation. "When a company sells Percs, it's sending a clear message that management feels its common is undervalued, and ... it's probably better to own the common stock than the Percs."

Pratt (December 2, 1991) presented a rather different view on the role that Percs plays in the information asymmetry. "One of the most appealing things about Percs is their capacity to neatly bridge the huge gap that often exists between the perspectives of issuers and investors on the potential of a company's common --- and to do so on terms acceptable to both parties." Here, neither side is superior to the other one. The two sides just disagree with each other. The magic power that Percs has is to bring the quarrelling parties into a deal.

In Citicorp's \$1 billion offering, Pratt (October 19, 1992) saw another big structural advantage of Percs. After Citicorp announced the plan to issue \$650 million Percs but before it made the offer, its common price dropped more than 25%, probably due to the announcement of the plan, the resignation of the president and the disappointing quarter earnings. Instead of having second thoughts, Citicorp just went ahead and even expanded the deal to \$1 billion. "With a Percs deal," explains Pratt, "the issuer keeps all the upside above the cap, and actually is theoretically indifferent to the price at which the offering is sold." Thus, timing of issuance becomes meaningless. Managers can just go and raise equity by Percs without bothering to think about whether the time is good or not to do that.

A few articles have talked of tax advantages of Percs. Robert Willens, a tax expert at Lehman Brothers, recommended "a way to generate the losses without getting totally out of the stock" (Saunders, January 6, 1992). His advice to those in need of year-end losses: "Sell the common stock and replace it with the Percs." He believes "the IRS will deem them (Percs) to be sufficiently different from the common to avoid wash sale problems".

In a Risk's article, an anonymous author (October 1992) referred to the tax advantage of Percs for institutional investors. "Corporations pay tax on only 30% of

intercompany dividend income; ... this allows corporate buyers of preferred stock to collect as much as 89.8% of stock dividends tax-free."

For both theoretical and practical reasons, the price parity between derivative or hybrid securities and their relevant securities always evokes attention. Percs is not exceptional. The appropriateness of its price is questioned in several articles.

In an article in The Economist, an anonymous author (January 11, 1992) tells the readers, "Indeed, Merrill Lynch, an American investment bank, reckons it can reproduce GM's Percs and sell them more cheaply to investors." The information is so brief that no details about the possible reproduction have been mentioned.

Harty had the same opinion about GM's Percs as the unnamed person at Merrill Lynch. He said, "the GM Percs are substantially overvalued" (Pratt, January 13, 1992). Referring to those institutional investors who resold Percs they bought from the original offering to retail investors, he warned, "the Street risks tarnishing the image of an important new product at a critical time in its young life".

In another report by Pratt (March 2, 1992), Harty complained that Tandy Percs was undervalued. On the day of offering, Tandy Percs closed down a quarter while the common added a half point. The performance gap got even wider in

the next few days. "That is not supposed to happen," said Harty. He was not alone with such an assessment. "Several sources said," wrote Pratt, "that Tandy is merely the latest and most obvious case of inefficient trading in the Percs market."

One month later, a similar comment appeared in a Business Week article (Light, April 20, 1992).

"(Percs) are supposed to trade in tandem with the common. But since they were first sold, several Percs issues -- notably those of Kmart, Olin, Tenneco and Texas Instruments -- have lagged behind their companies' common."

Three months later, comments changed. "(Percs') performance improves," Pratt (July 27, 1992) reported. "... all but 4 of the 13 Percs-type issues are currently trading at a premium to their underlying common stock." In the same report by Pratt, Harty expressed his reassessment of the Percs market. "Percs are doing exactly what they are supposed to do."

In his own article on Percs, Harty (July-August 1992) presents the similarity between Percs and Prime¹. Like the

¹ Prime and Score are derivatives of a common stock created by a trust fund where the common stock is deposited. The trust has a maturity of five years. Prime receives all the dividends during the five years and any increase in the stock price up to a termination value by the end of the five-year period. Score receives appreciation of the stock above the termination value when the trust is matured. Due to an unfavorable tax classification, no Primes and Scores have been issued since 1986. Those issued before that tax classification have all expired.

combination of Prime and Score¹, a combination of Percs and Leap² effectively reconstructs the common stock. Nevertheless, the reconstruction of common stock with Percs and Leap, as Harty shows in a diagram, can hardly be as precise as that with Prime and Score.

None of the articles cited above have made any tests on the opinions about Percs they brought up. Finnerty (October 1993), in his paper presented at the annual meeting of the Financial Management Association, tested the market reactions to the announcements of Percs issues and analyzed the price behavior of Percs relative to the equivalent package composed of the underlying common stock and call option. He found that the stock market reacted negatively to the initial announcement of Percs issue and the reaction is weaker than the market reaction to the announcement of conventional convertible preferred stock issues. He suggests that the weaker market reaction "may be due to the positive effect of the issuer's retention of a call option on the underlying common shares". Besides the market reaction to the initial announcement, he also tested

² Leaps, an abbreviation of Long-term Equity Anticipation security, are long-term call and put options with initial maturity of one, two or three years. They were introduced by Chicago Board Options Exchange in October 1990. About six months later, the American Stock Exchange, the Pacific Stock Exchange and the Philadelphia Stock Exchange introduced their own Leaps.

the market reaction to the follow-up announcement that reveals the terms of Percs issue. The results show that the market reaction to the follow-up announcement was insignificant. "These results imply that the announcement of the new issue terms does not convey any incremental useful information to the market place", Finnerty writes. "Perhaps this suggests that even though Percs are relatively new, their terms are sufficiently standardized that the announcement of particular terms of an issue imparts no additional useful information." The author also found that the first three Percs, issued by General Motors, Kmart and Texas Instruments, were overpriced while the rest were underpriced. He refers such overpricing-underpricing pattern to Tufano's (1989) seasoning process scenario, which proposes that early issuers of innovative securities may take advantage of the unfamiliarity of investors with the structure of the new security in the first few issues.

In summary, two issues have been brought into attention. One is whether Percs, as a hybrid security, is fairly priced compared to the relevant securities. The other is whether Percs, as a new security, makes any contributions to investors or companies. Some experts suspected that Percs might have been mispriced and there might be arbitrage opportunities which could violate the efficient market hypothesis. Others suggested that Percs

might help investors reduce transaction costs and tax costs. It was also recommended that Percs might be able to help the issuer relieve the negative price effect that equity offerings often have on the common stock.

This dissertation conducts a research on the two issues above. The first part of the dissertation, which is composed of Chapter III and IV, is concentrated on the first issue. Chapter III analyzes Percs-common price parity and arbitrage restrictions and establishes testable hypotheses about them. Chapter IV presents the results of the tests on those hypotheses. The second part, including Chapter V and VI, is focused on the second issue. Chapter V gives an analysis of market reaction to the issue of Percs. Chapter VI is an event study on Percs offerings. Chapter VII summarizes the dissertation.

Researches of Derivative Securities

A great amount of research has been conducted on derivative securities, including synthetic, hybrid securities, etc. One kind of research on derivative securities is focused on valuation. Contingent-claims pricing models have been frequently applied to the valuation of derivative securities. Those models apply the same techniques as Black-Scholes Model: stock price is assumed to follow a diffusion process; the change of stock price is

described by a differential equation; constraints are derived from the contract terms of the security; the solution of the differential equation under the constraints gives an estimated value of the security.

Ingersoll (1977) developed a contingent-claims pricing model for convertible securities. The model can reflect those aspects that have been ignored by the previous models, such as the possibility of early conversion. It provides a powerful tool for the analysis of convertible securities. Nevertheless, it does not give satisfactory empirical results.

"Unfortunately even casual empiricism indicates that the implied strategy of Theorem III (optimal call policy) is completely at odds with the observed practice of firms. ... The assumptions underlying Theorem III, no transaction costs, no corporate taxes, and no required notice of call, all market imperfections not considered here, are possible explanations for this discrepancy between theory and practice (p.320)."

McConnell and Schwartz's (1986) analysis of LYON, Liquid Yield Option Note, is another typical example of contingent-claims pricing model. LYON is a zero-coupon, convertible, callable and redeemable bond. With such a complexity, the pricing equation is hard to be solved by any algebraical methods. The authors used numerical techniques to find the solution for a LYON issued by Waste Management. The results indicated that "the model is sufficiently

accurate to provide a rough guideline for the pricing of new LYON issues".

Another focus of derivative security research is the "mispricing" of those securities. This issue can not be separated from the issue of valuation, but it is more concerned with the relationship between the derivative security and the relevant securities. In the research of "mispricing", LEGO approach (Smithson, 1987) or financial engineering (Finnerty, 1988) received more applications. Since derivative securities can usually be replicated, precisely or roughly, by the relevant securities, the price of the derivative should be in parity, strict or loose, with the price of an equivalent package made up of the relevant securities. The equivalent package, therefore, can be used as a bench mark for the derivative. Any discrepancy in price between the derivative and the bench mark would be viewed as "mispricing", a possible violation of the efficient market hypothesis which needs explanations.

Jarrow and O'Hara (1989) investigated the "mispricing" of Prime and Score relative to their underlying common stock. By a nonparametric procedure, Jarrow and O'Hara found that Prime and Score prices exceeded the underlying stock prices by a considerable amount. They argued that the increased value is due to the score's ability to save on the costs of dynamic hedging. They also demonstrated how short

sale restrictions and trust size constraints impeded the ability to arbitrage price disparities.

Chen and Kensinger (1990) analyzed MICD, a hybrid security invented by Chase Manhattan Bank. MICDs, Market-Index Certificate of Deposit, are variable-rate certificates of deposit. Their interest rates are contingent upon the performance of S&P 500 Index but with a guaranteed minimum level. The call version of MICD offers an interest that rises in proportion to the increase of the index, while the put version pays higher interest the more the index declines. By decomposing the hybrid into a risk-free pure discount bond, a call option on the scaled market index, and a short position of another call option on the market index, Chen and Kensinger established an equilibrium model. With that model, they compared the standard deviations implied by MICDs and by the market index. They found most MICD implied standard deviations are greater than the market index implied standard deviation. The evidence indicated that most MICDs were overpriced, especially those of put version. They suggest that the overpricing might be due to the value of the hedging vehicle contributed by the put version of MICD. "Such a hedging vehicle would be particularly attractive to an investor whose tax situation makes it undesirable to liquidate the stock position, and who would therefore be willing to pay a premium."

In a recent article, Finnerty (Summer 1993) presented a research on SIGN, Stock Index Growth Note. By adding the value of tax arbitrage, the value generated from savings of transaction costs and the value attributable to the new investment alternative, he demonstrated that the predicted value of SIGN is almost equal to the market price.

The three articles mentioned above are only a few examples of this kind of research. Other articles in this area include Chen and Kensinger's puttable stock (1988), Smith's FRN (1988), Chen and Sears' SPIN (1990), and a considerable number of others. Many of the articles presented evidences of "mispricings". Most of the discovered "mispricings" have been linked to transaction costs, taxes or the value in new opportunities rather than market inefficiency.

Researches of Equity Offering

Studies on seasoned equity offerings generally found that the stock price had a significant decline in the period surrounding the announcement date (see Smith, 1986). A number of explanations were given to the observed evidence. Four of them are reviewed here.

One explanation hypothesized that the demand for a firm's share is a downward-sloping curve (see Scholes,

1972). The new issue expands the supply and thus depresses the price.

Another explanation related the drop of stock price to the redistribution of wealth caused by the change of capital structure. The extra equity raised by the new issue reduces the debt ratio and consequently the risk of the debt. Therefore, the value of debt rises. As the wealth is moved to the debt, the value of equity decreases (see Black and Scholes, 1973).

The third explanation is associated with the assumption of asymmetric information (see Ross, 1977; Myers and Majluf, 1984). Under this assumption, investors will view the issue of equity as a signal that the common stock is overvalued. As they respond to the signal by adjusting their estimations about the firm, the price of stock declines.

The fourth explanation is connected to Jensen and Meckling's (1976) agency model. The model predicts that larger percentage shareholdings by management decrease the potential conflicts of interest between the managers and the outside shareholders. Thus, the issue of common stocks, which increases outstanding shares and decreases management percentage shareholdings, will have a negative impact on firm value and stock price. Both pros and cons have been found for each of the explanations in empirical tests.

Asquith and Mullins (1986) made a series of tests on the hypotheses implied by the first three explanations mentioned above. In addition to significant declines of stock prices at the announcement of common stock offering, they found a negative relation between the stock price reduction and the size of the offering. That is a unanimous support to all of the three explanations. However, further tests did not give equal support to the three scenarios. One test result showed that the stock price reduction was associated with the decline of performance that the stock experienced through the two-year period surrounding the announcement. Another test result indicated that the price effect on industrial firms was stronger than that on utility firms. The two results both conform to the signaling scenario but they did not provide any obvious clues to the other two scenarios. A comparison between the effect of primary offerings by companies and the effect of secondary offerings by shareholders was an evidence against the wealth redistribution scenario. As implied by the wealth redistribution scenario, secondary offerings should not have significant impact on stock price, because they do not cause any change in capital structure. The test results, however, show that secondary offerings have similar significant impact on the stock price as do primary offerings.

Like Asquith and Mullins and many others, Masulis and Korwar (1986) observed a significant fall in the price of common stock on the announcement of common stock offerings. They regressed the announcement period stock return against a number of variables. One of the variables was the proportional change in outstanding shares of common stock. It showed a significant negative impact on the announcement period return. This evidence supported both the agency model and the signaling model, as the authors stated.

Kalay and Shimrat (1987) tried to distinguish the relative importance of the explanations about the negative market reaction to a common stock issue. They investigated the performance of bond price during the period around a stock offering announcement. The empirical evidence indicated that bond prices reacted negatively to the announcement of a stock issue. They regarded the evidence consistent with the signaling hypothesis but inconsistent with the price pressure and the wealth-redistribution hypotheses.

The four explanations, downward-sloping demand, wealth redistribution, asymmetric information and agency theory, although originally generated for common stock offerings, provide implications to Percs offerings. On the other hand,

an event study on Percs offerings will add new findings about those explanations to the body of existing evidence.

CHAPTER III

PRICE PARITY AND ARBITRAGE RESTRICTIONS

Percs-Common Price Parity

Consider a firm which has two kinds of equity, common stock and Percs. Let E_t be the value of total equity at time t , S_t the value of a share of common stock and P_t the value of a share of Percs at time t . Let n_s and n_p be the numbers of common shares outstanding and Percs shares outstanding. At any time t ,

$$E_t = n_s S_t + n_p P_t \quad (1)$$

FIGURE 1

VALUE OF EQUITY

<u>t</u>	<u>t+1</u>	<u>t+2</u>
$E = n_s S + n_p P$	$E_u = uE - n_s D_s - n_p D_p$ $= n_s S_u + n_p P_u$	$E_{uu} = uE_u = n_s S_{uu} + n_p P_{uu}$
	$E_d = dE - n_s D_s - n_p D_p$ $= n_s S_d + n_p P_d$	$E_{ud} = dE_u = n_s S_{ud} + n_p P_{ud}$
		$E_{du} = uE_d = n_s S_{du} + n_p P_{du}$
		$E_{dd} = dE_d = n_s S_{dd} + n_p P_{dd}$

For convenience, assume E_t follows a binomial process. The return of E_t for a period is either u or d , where $u > r > d > 0$ with r as the risk-free return. The sample path of the value of total equity from t to $t+2$ would look like that in Figure 1.

At time t , E_t has the value E . One period later, E_{t+1} is either E_u or E_d . By the end of the second period, E_{t+2} has four possible values, E_{uu} , E_{ud} , E_{du} and E_{dd} . The end of the first period coincides an ex-dividend date. D_c is the dividend per common share and D_p the dividend per Percs share. $D_p > D_c$. The total dividends $n_c D_c + n_p D_p$ is subtracted from the equity on that day. S_t and P_t move along with E_t by (1). Following the same rules shown in the two periods, the diagram in Figure 1 can be further expanded to any point till time T , the mandatory conversion date of Percs. On that date, the payoff to the Percs will be

$$P_T = \min\{E_T / (n_c + n_p), K\}, \quad (2)$$

and the payoff to the common stock

$$S_T = \max\{E_T / (n_c + n_p), (E_T - n_p K) / n_c\}, \quad (3)$$

where K is the cap of the Percs.

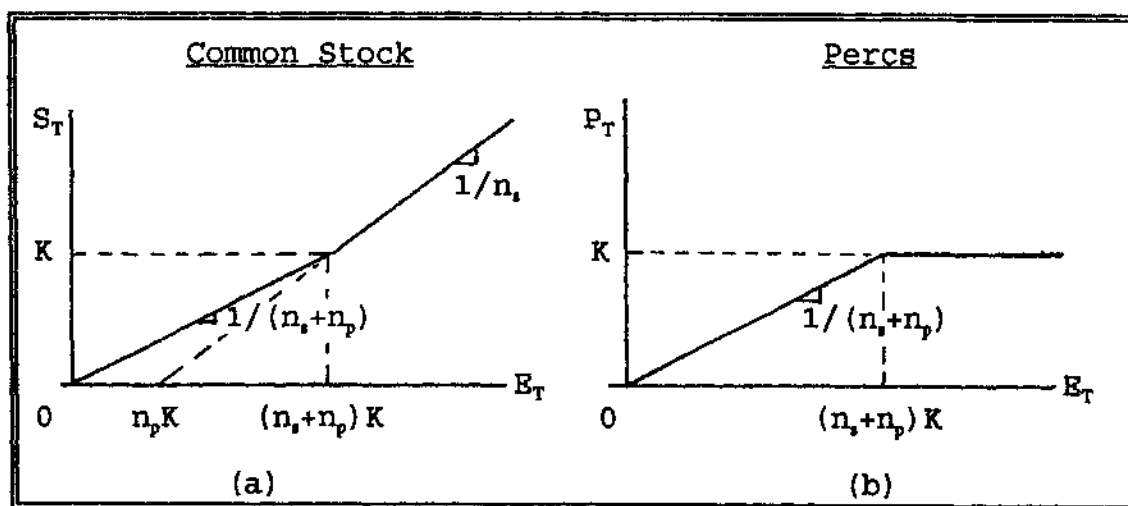
Suppose a call option with exercise price X is also matured at time T . Its payoff at T will be

$$\begin{aligned} C_T &= \max\{0, S_T - X\} \\ &= \max\{0, \max\{E_T / (n_c + n_p), (E_T - n_p K) / n_c\} - X\}, \end{aligned} \quad (4)$$

where the second equation is derived by a substitution of equation (3).

All of the payoffs are contingent on the value of total equity. In a broad sense, the common stock and the Percs are both generalized options on the equity. See Figure 2.

FIGURE 2
GENERALIZED OPTIONS ON EQUITY



The value of the common stock S_T will be $1/(n_s+n_p)$ of the total equity if E_T is below $(n_s+n_p)K$. As E_T goes above that, it will become a call option on E_T/n_s , with exercise price $n_p K/n_s$. See diagram (a) in Figure 2. S_T goes up with a slope of $1/(n_s+n_p)$ till $E_T = (n_s+n_p)K$. Then the slope rises to $1/n_s$. The more shares of Percs issued, the bigger the jump of the slope. The value of Percs will also be $1/(n_s+n_p)$ of the total equity with E_T up to $(n_s+n_p)K$. If E_T

goes beyond that, it will stay at K , no matter how big the value of E_T is. See diagram (b) in Figure 2.

Let the exercise price of the call option equal to the cap of the Percs, $X = K$. Divide the range of E_T into two regions, $E_T \leq (n_s+n_p)K = (n_s+n_p)X$ and $E_T > (n_s+n_p)K = (n_s+n_p)X$. The payoffs at T to the common stock S_T , the Percs P_T and the call option C_T contingent on the value of total equity E_T are shown in Table 2.

TABLE 2
PAYOFFS AT T CONTINGENT ON THE VALUE OF TOTAL EQUITY

State	$E_T \leq (n_s+n_p)X = (n_s+n_p)K$	$E_T > (n_s+n_p)X = (n_s+n_p)K$
S_T	$E_T / (n_s+n_p)$	$(E_T - n_p K) / n_s$
C_T	0	$(E_T - n_p K) / n_s - X$
P_T	$E_T / (n_s+n_p)$	K

It is easy to see in Table 2 that the payoff to the Percs on its mandatory conversion date, under any state, is equivalent to a "buy-write", or covered call, position, given $X = K$. That is

$$P_T = S_T - C_T. \quad (5)$$

The equivalence of the two sides in (5) should hold at any time t before T only if there are no distributions of the equity to any of those securities during the period from t to T . If there are dividend payments in that period, the

equivalence will not hold at time t since the two sides are going to receive different amounts of dividend.

With the values of dividends excluded, the two sides of (5) would be equivalent at any time t prior to T :

$$P_t - V_t(D_p) = S_t - C_t - V_t(D_s), \quad 0 \leq t \leq T, \quad (6)$$

where $V_t(D_s)$ and $V_t(D_p)$ are the values of the dividends to be paid to the common stock and the Percs, respectively, during the period from t to T .

Although Percs is allowed to be redeemed before maturity, it is prevented from early redemption by the mandatory payment of the total unpaid extra dividends and the accrued dividends. Therefore, the option contained in Percs, C_t , is approximate to a European-style call option.

By rearrangement of (6),

$$P_t = S_t - C_t + [V_t(D_p) - V_t(D_s)]. \quad (7)$$

Equation (7) gives the relationship between Percs and the corresponding common stock and call option. It suggests that buying a share of Percs is equivalent to buying a share of common stock and writing a call option plus buying an annuity which equals the extra dividends. It also suggests that the price of Percs should equal to the price of a portfolio composed of a share of common stock, a short position in a call option and an annuity. equation (7) is called Percs-Common Price Parity.

When a Percs is issued, the price of Percs is equal or very close to the price of common, $P_0 \approx S_0$. The subscript 0 denotes the issue date. By (7),

$$C_0 \approx V_0(D_p) - V_0(D_s) \quad (8)$$

The price of the call option in Percs on the issue date should be approximate to the value of the extra dividends.

The Synchronism between Common and Percs

A direct test on (7) needs P_t , S_t , C_t , $V_t(D_p)$ and $V_t(D_s)$. Daily records of P_t and S_t are available on a number of convenient resources like The Wall Street Journal, Daily Price Records of New York Stock Exchange, etc., but C_t , $V_t(D_p)$ and $V_t(D_s)$ need to be evaluated. Although Leaps are available to some Percs, their maturity dates and exercise prices rarely match those of the C_t . Therefore, Leaps cannot be used as C_t here. The evaluation of C_t involves applications of pricing models like the Black-Scholes Formula or the Binomial Option Pricing Formula while the evaluation of $V_t(D_p)$ and $V_t(D_s)$ involves estimation of future dividends and discount rates. An indirect test can avoid C_t , $V_t(D_p)$ and $V_t(D_s)$. It is a test on the synchronism of prices between Percs and the underlying common stock.

Take derivative of (7) with respect to S_t :

$$dP_t/dS_t = 1 - dC_t/dS_t. \quad (9)$$

By the principle of option pricing (see Merton, 1973),

$0 \leq dC_t/dS_t \leq 1$. Then by (9),

$$0 < dP_t/dS_t < 1, \quad (10)$$

where the two extreme points corresponding to $dC_t/dS_t = 0$ and $dC_t/dS_t = 1$ are ignored.

The left part of (10), $dP_t/dS_t > 0$, suggests that the price of Percs moves in the same direction of the underlying stock price, holding all other factors constant. The right part of (10), $dP_t/dS_t < 1$, indicates that the price of Percs will move less than the price of common, given that factors other than common stock price are held constant.

Design of Tests on Percs-Common Synchronism

Let

$$dP_t = P_t - P_{t-1}, \quad (11)$$

$$dS_t = S_t - S_{t-1}. \quad (12)$$

From $t-1$ to t is a short period like one day. As (10) suggests, the price of Percs will follow the price of the underlying common, i.e.,

$$P_t - P_{t-1} > 0, \quad \text{if } S_t - S_{t-1} > 0, \quad (13)$$

$$P_t - P_{t-1} < 0, \quad \text{if } S_t - S_{t-1} < 0. \quad (14)$$

It is important to notice the difference between Formulas (13) and (14) and Formula (10). In (10), factors other than common stock price are all held constant. In (13) and (14), those factors cannot be held constant.

Equation (10) is derived from an ideal situation while (13) and (14) are records of the real world.

Rearrange the right part of (10) as

$$dP_t < dS_t, \quad \text{if } dS_t > 0, \quad (15)$$

$$dP_t > dS_t, \quad \text{if } dS_t < 0. \quad (16)$$

or

$$dP_t - dS_t < 0, \quad \text{if } dS_t > 0, \quad (17)$$

$$-dP_t - (-dS_t) < 0, \quad \text{if } dS_t < 0. \quad (18)$$

Substitute dP_t and dS_t in (17) and (18) by (11) and (12):

$$(P_t - P_{t-1}) - (S_t - S_{t-1}) < 0, \quad \text{if } S_t - S_{t-1} > 0, \quad (19)$$

$$(P_{t-1} - P_t) - (S_{t-1} - S_t) < 0, \quad \text{if } S_t - S_{t-1} < 0. \quad (20)$$

Let

$$\epsilon_{U_t} = P_t - P_{t-1}, \quad S_t - S_{t-1} > 0, \quad (21)$$

$$\epsilon_{D_t} = P_t - P_{t-1}, \quad S_t - S_{t-1} < 0, \quad (22)$$

$$\eta_{U_t} = (P_t - P_{t-1}) - (S_t - S_{t-1}), \quad S_t - S_{t-1} > 0, \quad (23)$$

$$\eta_{D_t} = (P_{t-1} - P_t) - (S_{t-1} - S_t), \quad S_t - S_{t-1} < 0. \quad (24)$$

ϵ_{U_t} and ϵ_{D_t} are the changes of Percs price over time as common stock price goes up and down, respectively. η_{U_t} and η_{D_t} are the differences between the change of Percs price and the change of common stock price as common stock price goes up and down respectively. Like (13), (14), (19) and (20), (21) through (24) are more representative of the real world. ϵ_{U_t} , ϵ_{D_t} , η_{U_t} and η_{D_t} include not only impacts from the change of common stock price but also that from all the

other factors. Besides, they include measurement errors in P_t and S_t .

Instead of a one-dimensional function of the underlying stock, the price of Percs is related to a number of other factors like the interest rate, the volatility of the common stock, the expected return of the common stock, the expected return of itself, the time to mandatory conversion, etc. In a short interval like one day, those factors are relatively stable. Their impacts on the price of Percs, compared to that of common stock price, are normally small. For example, the time to mandatory conversion would have such a small impact on the change of Percs price during a day that the impact might be ignored. Occasionally, some of those factors, interest rate for instance, may change dramatically and their impacts can come out to be quite strong. Such strong impacts would appear as random pulses.

Measurement errors may come from bid-ask spreads. Suppose P_t and S_t are daily closing prices, which can be either bid or ask price by chance. The bid-ask spread may magnify or shrink the change of price. In case that P_t is an ask price while P_{t-1} is a bid price, the measured change of price $P_t - P_{t-1}$ will be larger than the actual change. On the other hand, when P_t is a bid price and P_{t-1} an ask price, the measured change will be smaller than the actual change. Similar problems exist in the measurement of common

stock price. The chance that the closing price is a bid price should be equal to the chance that it is an ask price. The error caused by bid-ask spread would be purely random.

Measurement errors can also come from the nonsynchronism of data. Ideally, P_t and S_t should happen simultaneously. Nevertheless, the prices in record did not necessarily occur at the same time although they are both closing prices. One could occur in the morning while the other in the afternoon. The liquidity of Percs is relatively low compared to that of common stocks. It is more likely that the closing price of Percs in record actually occurred before the closing price of the common stock. The measured change in Percs price, $P_t - P_{t-1}$, would be more likely to happen before that in common stock, $S_t - S_{t-1}$. With P_t and S_t as daily data, the problem of nonsynchronism should not be severe, because most time prices of common stock and Percs would not have severe fluctuations during a short period like one day. In case the price changes are big during the day and one of the two prices, P_t and S_t , comes before while the other comes after the big change in price, the problem of nonsynchronism becomes severe. Such errors caused by nonsynchronism of data, as that caused by bid-ask spread, would be random in nature.

Assume the aggregation of the impacts from factors other than the common stock price and measurement errors is

a random term with zero mean and serial independence. Then, tests on (13), (14), (19) and (20) can be conducted on the following hypotheses.

(I) Hypothesis on Percs-common synchronism in upward movement.

$$H_0: E\{\epsilon_{Ut}\} \leq 0; \quad H_1: E\{\epsilon_{Ut}\} > 0.$$

The $E\{\cdot\}$ represents the population mean in the hypothesis statements outlined in this section. A rejection of H_0 indicates that the Percs did not tend to go down as the underlying common stock was going up.

(II) Hypothesis on Percs-common synchronism in downward movement.

$$H_0: E\{\epsilon_{Dt}\} \geq 0; \quad H_1: E\{\epsilon_{Dt}\} < 0.$$

A rejection of H_0 indicates that the Percs did not tend to go up as the underlying common stock was going down.

(III) Hypothesis on the magnitude of upward movement.

$$H_0: E\{\eta_{Ut}\} \geq 0; \quad H_1: E\{\eta_{Ut}\} < 0.$$

A rejection of H_0 indicates that on average the Percs did not tend to move more than the common stock when the latter went up.

(IV) Hypothesis on the magnitude of downward movement.

$$H_0: E\{\eta_{Dt}\} \geq 0; \quad H_1: E\{\eta_{Dt}\} < 0.$$

A rejection of H_0 indicates that on average the Percs did not tend to move more than the common stock when the latter went down.

Any failure of rejection to the original hypotheses above would leave suspicions to the performance of the Percs -- whether it moved properly in relation to the underlying common stock.

The tests on the four hypotheses above have not touched the question about the price level of Percs. An overall rejection across the four hypotheses would not suggest that the Percs have been priced at an appropriate level implied by the relevant securities. The following section will discuss the examination of the price level of Percs.

Design of Tests on Price Parity

With C_t , $V_t(D_p)$ and $V_t(D_s)$ evaluated, one way or another, a direct test on (7) can be conducted. Let

$$\delta_t = P_t - S_t + C_t - [V_t(D_p) - V_t(D_s)] \quad (25)$$

The δ_t represents the "mispricing" of Percs. Meanwhile, like the ϵ s and η s in the last section, δ_t includes various error terms.

Again, suppose P_t and S_t are daily closing prices. The bid-ask spread may cause imparity between the observed prices of Percs and common stock even though the two are in good parity. The nonsynchronism may induce seeming imparity as well. If the records of P_t and S_t did not come from the same time, the measured imparity between them may be due to the change of price over time.

Another kind of errors in δ_i are estimation errors. To evaluate C_i , $V_i(D_p)$ and $V_i(D_s)$, one needs to estimate a number of parameters, such as the variance of stock return, the expected return of Percs, the expected return of common stock, and so on. Estimation errors of those parameters will enter the estimated values of C_i , $V_i(D_p)$ and $V_i(D_s)$ and then get into δ_i . The pricing models can also generate errors, because the actual environment may differ from what is assumed in the models.

Denote the amount of mispricing of P_i as m , and the aggregate errors as e_i . Then,

$$\delta_i = m + e_i \quad (26)$$

Assume all error sources are cross-sectionally and serially independent, and the aggregate error has mean of zero, i.e., $E\{e_i\} = 0$. Then, $E\{\delta_i\} = m$. Based on these assumptions, the following hypothesis is constructed.

(V) Hypothesis on mispricing of Percs.

$$H_0: E\{\delta_i\} = 0; \quad H_1: E\{\delta_i\} \neq 0.$$

A rejection of H_0 indicates that the Percs is mispriced.

The Restrictions of Arbitrage

A violation of price parity, even statistically significant, does not necessarily imply any arbitrage opportunity, because transaction costs can prevent

arbitrage profit as the price imparity is kept within a certain range. Until the price of Percs goes below a lower bound, say P_{L_t} , or above an upper bound, say P_{U_t} , arbitrage profit is yet guaranteed. The P_{L_t} and P_{U_t} are the boundaries of the range where arbitrages are prohibited.

As P_t goes below P_{L_t} , an arbitrageur can make profit by buying a share of Percs and a call option, and short selling a share of common stock. Since the long and short positions will cancel each other at the maturity, the trading will be profitable if the following condition is satisfied.

$$V_t(D_p) - V_t(D_s) > P_t + C_t - S_t + Q_{L_t}. \quad (27)$$

In other words, the extra dividend is so high that it can cover the debit balance $P_t + C_t - S_t$ and the transaction costs Q_{L_t} which occurs in the arbitrage beginning at time t . The Q_{L_t} includes trading commissions, bid-ask spreads and expenses due to short selling restrictions, etc. Suppose the arbitrageur is an investor other than the market makers. When he buys or sells any securities, he needs to pay commissions. In addition, he needs to bear the costs embedded in the bid-ask spread. For short selling, there is an extra cost which is mainly the loss of interest on the short sale proceeds. Let γ_p , γ_s , and γ_c be the trading commissions and λ_p , λ_s , and λ_c be the transaction costs due to bid-ask spread for Percs, common stock and call option, respectively. All the γ s and λ s are percentages of the

transaction volume in dollars. Let θ be the loss of interest as a percentage of the short sale. Then, the total costs to start the arbitrage plus the costs of short selling restrictions is

$$(\gamma_p P_t + \gamma_s S_t + \gamma_c C_t) + (\lambda_p P_t + \gamma_s S_t + \lambda_c C_t) + \theta S_t. \quad (28)$$

To close the arbitrage position, transaction costs may or may not be involved. If the common stock price at that time is below the cap, the Percs share will be converted to a common share. The arbitrageur can use the common share to cover the short position in common stock and let the out-of-money call option expire. Then, all the positions are closed while no transaction costs occur. If the common price at that time is above the cap, the Percs will be converted to a fraction of common share. The fraction of common share is not enough to cover the short position in common stock. The arbitrageur needs to use the in-the-money call option to cover the rest of the short position. He can sell the Percs at the price equal to the cap and use the proceeds to exercise the call option. Then, he has a full share of common stock and is able to cover the short position. In the sale of Percs, he needs to pay commission on the price equal to K . To exercise the option, he needs to pay commission on the exercise price X . The total commissions would be $\gamma_p K + \gamma_s X$. Another way to close the entire position is to sell the call option by a cash

settlement and use the proceeds to buy a fraction of the common stock. That fraction of common stock plus the fraction from the conversion of the Percs will make up a full share of common stock. The second process might be less expensive than the first. No matter what process the arbitrageur takes, some transaction costs will occur by the end of the arbitrage, if the common stock price goes above the cap. Let q be the present value of the end-of-period transaction costs. The q is a product of a discount factor, the probability that the common stock price is above the cap and the expected costs of the transactions that close the entire position. Adding q to (28), the total transaction costs that would occur in the arbitrage is

$$Q_{L_t} = \gamma_p P_t + \gamma_s S_t + \gamma_c C_t + \lambda_p P_t + \lambda_s S_t + \lambda_c C_t + \theta S_t + q \quad (29)$$

All the parameters, γ_p , γ_s , γ_c , λ_p , λ_s , λ_c , and θ could vary among investors and securities. An investor doing a big trade through a discount broker would have lower γ_p , γ_s , γ_c than an investor doing a small trade through a full service broker. A security with high liquidity would have a smaller spread than a security with low liquidity. Denote the minimal value of Q_{L_t} as \underline{Q}_{L_t} . Corresponding to the lower bounds of those parameters, i.e., the minimal commission rate, the minimal cost due to bid-ask spread and the minimal cost resulted from short sale restrictions, \underline{Q}_{L_t} would determine the lower bound of the no-arbitrage interval P_{L_t} .

For a long-Perocs-short-common arbitrage opportunity to exist, the price of Perocs needs to be below P_{L1} :

$$P_t < P_{L1} = S_t - C_t + [V_t(D_p) - V_t(D_s)] - Q_{Ut} \quad (30)$$

In the other direction, as P_t goes above P_{U1} , an arbitrageur can make a profit by buying a share of common stock, writing a call option and short selling a share of Perocs. For such an arbitrage to be profitable, the credit balance $P_t + C_t - S_t$ needs to be big enough to cover the extra dividends $V_t(D_p) - V_t(D_s)$ and the total transaction costs Q_{Ut} :

$$P_t + C_t - S_t > [V_t(D_p) - V_t(D_s)] + Q_{Ut} \quad (31)$$

The total transaction costs involved in this arbitrage for an individual investor is

$$Q_{Ut} = \gamma_p P_t + \gamma_s S_t + \gamma_c C_t + \lambda_p P_t + \lambda_s S_t + \lambda_c C_t + \theta P_t + q \quad (32)$$

where γ_p , γ_s , γ_c , λ_p , λ_s , λ_c , θ and q are the same as that in (29).

The costs related to commission and bid-ask spread at the beginning of this arbitrage would be the same as they used to be in (29), although the transactions are reversed. That is, purchase is reversed to sale and sale is reversed to purchase.

The present value of the transaction costs by the end of this arbitrage process, q , is also the same as that in (29). If the common stock price at the maturity date is below the cap, the arbitrageur may use the common share in hand to cover the short position of Perocs while the call

option will be out of money and expire without being exercised. Then all the positions are closed without any transaction costs. If the common price at that time is above the cap K , the common stock will be called, because the exercise price X equals to the cap. To cover the short position of Percs, the arbitrageur needs a fraction of common stock with value equal to K . He can buy the fraction of common with the proceeds X from the option holder who pays the exercise price to call the common stock. To cancel out all his positions, the arbitrageur needs to pay commissions on the exercise price X for his sale of the stock and on the cap K for his purchase of the fraction of common share. An alternative way to close the arbitrage position is to use a fraction of the common stock with value K to cover the short position of Percs, sell the rest and use the proceeds to buy back the call option. Each transaction in this case can find a correspondent in the previous case.

The only difference between (32) and (29) is the cost of short selling restriction, which is θP_i in (32) and θS_i in (29). Since the Percs, instead of the common stock, is being short sold this time, the cost of short selling restriction in (32) is proportional to P_i rather than S_i . The short position of call option does not involve the cost of short selling restriction, because the call is covered.

The proceeds from writing covered call options are not subject to such restrictions.

Given the lower bounds of $\gamma_p, \gamma_s, \gamma_c, \lambda_p, \lambda_s, \lambda_c, \theta$ and q , the minimal value of Q_{Ut} , denoted as \underline{Q}_{Ut} , is determined. \underline{Q}_{Ut} , then, gives the upper bound of the no-arbitrage interval P_{Ut} . For a long-common-short-Percs arbitrage opportunity to exist, the Price of Percs has to be higher than P_{Ut} :

$$P_t > P_{Ut} = S_t - C_t + [V_t(D_p) - V_t(D_s)] + \underline{Q}_{Ut} \quad (33)$$

The condition in (30) and (33) are based on the assumption that there is a call option C_t available that has the same maturity as the Percs and an exercise price equal to the cap. In the market, however, there is not such a call option listed. The only things available are Leaps which have maturities and exercise prices different from that of C_t . The best substitute of C_t an arbitrageur has is the call type Leap whose maturity and exercise price are close to those of the C_t . For a long-Percs-short-common arbitrage, the arbitrageur needs to use a call type Leap that has longer maturity and lower exercise price than that of C_t , because a Leap with shorter maturity and higher exercise price cannot provide him a full hedge. Let L_{Lt} be the Leap which is the closest to C_t among those with longer maturity and lower exercise price than C_t . By the principles of option pricing, L_{Lt} has greater value than C_t , $L_{Lt} > C_t$. Replace C_t in (30) with L_{Lt} . The lower bound of the

no-arbitrage interval will drop from P_{L_u} to P_{L_u}' . Thus, (30) becomes

$$P_t < P_{L_u}' = S_t - L_{L_u} + [V_t(D_p) - V_t(D_s)] - Q_{L_u} \quad (34)$$

Meanwhile, the two parameters γ_e and λ_e in (29) should be changed to γ_L and λ_L . The subscript L refers to Leap.

Compared to (30), the condition of (34) is more meaningful in practice. A P_t below P_{L_u} suggests that arbitrages involving two listed and one non-listed securities are profitable, while a P_t below P_{L_u}' indicates that arbitrages consisting of three listed securities are profitable. The Leap L_{L_u} is more than enough for the set-up of a riskless position by the end of the arbitrage, but it is the best feasible choice that the arbitrageur has.

Similarly, for a long-common-short-Percs arbitrage, the arbitrageur needs to use a call type Leap which has a shorter maturity and a higher exercise price than C_t , because in this case Leaps with longer maturities and lower exercise prices than that of C_t cannot provide a full hedge. Let L_{U_t} be the leap which is the closest to C_t among those whose maturities are shorter and exercise prices are higher than that of C_t . Replace C_t in (33) with L_{U_t} and change γ_e and λ_e in (32) to γ_L and λ_L . By the principles of option pricing, $L_{U_t} < C_t$. Therefore, the upper bound rises from P_{U_t} to P_{U_t}' and (33) becomes (35):

$$P_t > P_{U_t}' = S_t - L_{U_t} + [V_t(D_p) - V_t(D_s)] + Q_{U_t} \quad (35)$$

Whereas (33) gives the condition for arbitrages involving two listed and one non-listed securities, (35) gives the condition for arbitrages made up of three listed securities. The Leap is not enough for the arbitrageur to thoroughly exploit the opportunity, but it is his best feasible choice.

Combine (34) and (35). The range where no arbitrages would exist is

$$P_{L_i}' < P_i < P_{H_i}' \quad (36)$$

Design of Tests on Arbitrage Restrictions

It would be more straight forward to test (34) and (35) than (7) since L_{L_i} and L_{U_i} are available in the market while C_i is not. Prices of Leaps are reported on newspapers like The Wall Street Journal and Barron's. However, Q_{L_i} and Q_{U_i} are extra in (34) and (35) compared to (7). As soon as Q_{L_i} and Q_{U_i} are available, the methodologies applied in the test of Percs-common price parity can be applied in the test of arbitrage.

Let

$$\mu_{L_i} = P_i - P_{L_i}', \quad (37)$$

$$\mu_{U_i} = P_i - P_{U_i}'. \quad (38)$$

Like δ_i in (25), μ_{L_i} and μ_{U_i} include the possible price imparity and various errors. Due to the lower liquidity of Leaps, the relative measurement error of Leap might be

larger than that of common stock or Percs, and the nonsynchronism between Leap and the other two securities could be more severe than that between the two securities.

Assume all the errors are cross-sectional and serially independent. In addition, the aggregate errors have a mean of zero. Tests on the existence of arbitrage opportunities can be conducted on the following hypotheses.

(VI) Hypothesis on long-Percs-short-common arbitrage.

$$H_0: E\{\mu_{11}\} \leq 0; \quad H_1: E\{\mu_{11}\} > 0$$

A rejection of H_0 indicates that profitable arbitrages by longing Percs and shorting common were almost impossible.

(VII) Hypothesis on long-common-short-Percs arbitrage.

$$H_0: E\{\mu_{01}\} \geq 0; \quad H_1: E\{\mu_{01}\} < 0$$

A rejection of H_0 indicates that profitable arbitrages by shorting Percs and longing common were almost impossible.

If both the original hypotheses are rejected, the results will be evidence that supports the efficient market hypothesis even the prices of Percs are not in parity with the relevant securities. Any failure of rejection to either of the two original hypotheses would arouse suspicion against the efficiency of the Percs market.

CHAPTER IV

EMPIRICAL TESTS

The Results of Tests on Percs-common Synchronism

Since the only data needed for tests on Hypothesis I through Hypothesis IV are the prices of Percs and common stocks, the four tests are conducted on all the companies in Table 1 over the entire period from the issue date of Percs to July 27, 1993, the last date when data were collected. Daily closing prices of Percs and common stocks were collected from the Daily Price Records of New York Stock Exchange and The Wall Street Journal. Stock splits and stock dividends were adjusted when needed. The prices of Percs and common stock are exhibited together in Figure 3 through Figure 18 in Appendix I. As illustrated in the diagrams, the price of Percs generally moves along with that of the common and the volatility of Percs is smaller than that of common. This is a direct evidence that supports the arguments given by (10).

Table 3 in Appendix II lists the results of the tests on Hypothesis I. The means of ϵ_{ut} are all positive and the t-values are all significant at the one percent level. The null hypothesis ($H_0: E\{\epsilon_{ut}\} \leq 0$) is rejected for all the companies without exception.

Table 4 in Appendix II shows the results of the tests on Hypothesis II. All the means of ϵ_{Dt} are negative and all the t-values are significant at the one percent level. The original hypothesis ($H_0: E\{\epsilon_{Dt}\} \geq 0$) is rejected without exception.

The results of the tests on both Hypotheses I and II provide support to (13) and (14). There existed a strong tendency of the Percs to move in the same direction as the common stock.

Table 5 and Table 6 in Appendix II present the results of the tests on Hypotheses III and IV. For all sixteen companies, the means of both η_{Ut} and η_{Dt} are negative and the t-values are significant at the one percent level. The null hypotheses ($H_0: E\{\eta_{Ut}\} \geq 0$ and $H_0: E\{\eta_{Dt}\} \geq 0$) are both rejected. The results of the tests on Hypotheses III and IV consistently support (19) and (20). The change in Percs' price tended to be smaller than the change in the price of the common stock.

The results of the tests on Hypothesis I through IV indicate that Percs performed in accordance to the principles of option pricing and the efficient market hypothesis. No significant evidence was found that Percs performed contrary to option pricing principles and efficient market hypothesis.

Preparation of Tests on
Price Parity and Arbitrage Restrictions

Only those companies with Leaps available were selected to test Hypotheses V through VII. For each company selected, only the period when Leaps were frequently traded was covered by the tests. The reason that the Percs without Leaps and the periods with little Leap trading were dropped from those tests is that Leaps are necessary for the tests on the arbitrage restrictions as well as the rolling estimation of implied stock volatility, which is crucial to the evaluation of C_t , the call option in Percs. By such criteria, eight Percs were selected. The Percs and their corresponding test periods are listed in Table 7.

TABLE 7
PERCS UNDER TESTS OF
PRICE PARITY AND ARBITRAGE RESTRICTIONS

Company	Test Period
General Motors	June 6, 1991 - July 6, 1993
Kmart	Sept. 23, 1991 - Jan. 26, 1993
Texas Instrument	Sept. 23, 1991 - Dec. 17, 1992
RJR Nabisco	Jan. 27, 1992 - July 26, 1993
Tenneco	Jan. 21, 1992 - Dec. 28, 1992
Sears Roebuck	Feb. 22, 1992 - Dec. 24, 1992
Westinghouse	June 3, 1992 - July 27, 1993
Citicorp	Oct. 16, 1992 - July 26, 1993

Daily prices of common stock and Percs, as mentioned before, were collected from the Daily Price Records of New

York Stock Exchange and The Wall Street Journal.

Adjustments for stock splits and stock dividends were made when necessary. Daily prices of Leaps were collected from The Wall Street Journal.

The continuous risk-free rate of return at time t , denoted as r_{ft} , was derived from daily prices of the treasury strip whose maturity was the closest to the maturity of the Percs under test:

$$r_{ft} = (1/T_{ft}) \log(100/A_t). \quad (39)$$

where T_{ft} is the time to maturity of the treasury strip while A_t is the bid-ask average price of the strip at time t . Daily bid and asked prices of treasury strips are collected from The Wall Street Journal. The risk-free rate was annualized.

The value of common stock dividends, $V_t(D_s)$, was evaluated by the formula

$$V_t(D_s) = \sum_{j=1}^n \exp(-r_{ft} T_{Dj}) D_{sj} \quad (40)$$

In (40), n is the number of dividends to be paid to the common stock from time t to the maturity of the Percs; D_{sj} is the amount of the j th dividend payment projected by Value Line; T_{Dj} is the length of time between t and the j th ex-dividend date, which was predicted on the basis of historical ex-dividend dates; and r_{ft} is the discount rate

of the common stock at time t . The r_{st} was estimated as the following.

$$r_{st} = r_{ft} + \beta_s (\bar{r}_m - \bar{r}_f) \quad (41)$$

where β_s is the average of the betas on Value Line over the test period. In case the beta on Value Line was an NMF (Not Meaningful Figure), the industry average was applied. Among the eight companies, only RJR Nabisco had a beta as an NMF on Value Line during the test period. The average beta of tobacco companies was used as a substitute. The \bar{r}_m and \bar{r}_f are the average rates of the market return and the risk-free return over the test period. Daily market returns were computed from daily S&P500 indexes. Daily risk-free returns are the same as that in (39).

The evaluation of $V_t(D_t)$ in (40) applies the most current dividend projection on Value Line. It moves to the new data as soon as Value Line updates the projection.

The value of Percs dividends

$$V_t(D_p) = \sum_{j=1}^n \exp(-r_{pt} T_{Dj}) D_{pj} \quad (42)$$

Equation (42) is similar to (40). In (42), n is the number of dividends to be paid to the Percs from time t to the maturity of the Percs; D_{pj} is the amount of the j th dividend payment, which is available in the prospectus; T_{Dj} is the time between t and the j th ex-dividend date which is also

available in the prospectus; and r_{pt} is the discount rate of Percs, which is given by (43).

$$r_{pt} = r_{ft} + \beta_p (\bar{r}_m - \bar{r}_f) \quad (43)$$

All of the terms on the right side of (43) except β_p are defined as in (41). The β_p is the beta of Percs. It could be estimated by a regression with Percs return against market return, but the estimate might be meaningless. For example, it might come out to be negative. To avoid such meaningless estimates, an approximation, as shown in (44), was applied.

$$\beta_p = \rho_{pm} \sigma_p / \sigma_m \approx \rho_{sm} \sigma_p / \sigma_m = (\sigma_p / \sigma_s) \beta_s, \quad (44)$$

where ρ_{sm} and ρ_{pm} are correlation coefficients of the common stock return with the market return and the Percs return with the market return, while σ_s and σ_p are standard deviations of the common stock return and the Percs return over the test period. As shown in the tests on Hypotheses I and II, Percs tends to move along with common stock. Therefore, ρ_{sm} and ρ_{pm} should not have great difference. The σ_s and σ_p were computed from daily returns of common stock and Percs over the test period. Daily returns of common stock and Percs were computed from daily prices and dividends.

The call option C_1 was evaluated by the Black-Scholes Formula adjusting for dividends:

$$\begin{aligned}
C_t &= W_t N(x) - K [\exp(-r_{ft} T_t)] N(x - \sigma_t \sqrt{T_t}) & (45) \\
W_t &= S_t - V_t(D_s) \\
x &= [\log(W_t/K) + r_{ft} T_t] / (\sigma_t \sqrt{T_t}) + \sigma_t \sqrt{T_t} / 2
\end{aligned}$$

where S_t is the common stock price; $V_t(D_s)$ is the value of stock dividends; K is the cap of Percs; T_t is the time to maturity of Percs; r_{ft} is the risk-free rate of return; σ_t is the standard deviation of common stock return; and $N(\cdot)$ is the cumulative standard normal distribution function.

Like σ_t in (44), σ_t is also an estimate of the standard deviation of common stock return. However, σ_t is estimated by a different approach. It is an implied standard deviation approach modified from Latane and Rendleman's (1976) approach:

$$\sigma_t = \left(\sum_{t=1}^M \sum_{j=1}^J \text{ISD}_{jt} d_{jt} \right) / \left(\sum_{t=1}^M \sum_{j=1}^J d_{jt} \right) \quad (46)$$

where ISD_{jt} is the standard deviation implied by Leap j at time t using Black-Scholes Formula; d_{jt} is the partial derivative of Leap j at time t with respect to the standard deviation using the Black-Scholes Formula³; J is the number of call-type Leaps listed; and M represents 30 calendar days (including Saturdays, Sundays and holidays).

³ $d_{jt} = \partial C_t / \partial \sigma$ where C_t is given by (45) and σ is substituted by ISD_{jt} .

Equation (46) gives a monthly moving average of implied standard deviations. The weights applied in the average are partial derivatives of Leap prices with respect to the standard deviation. The more sensitive a Leap is to the volatility of the underlying stock, the more weight its implied standard deviation is given in the estimation.

The difference between (46) and Latane and Rendleman's approach is the weight scheme. Latane and Rendleman's approach is a contemporary average. They do not weight implied standard deviations over time. They use weekly and monthly data and weight the standard deviations implied by option prices from the same time points. My research weights implied standard deviations both across Leaps and over time. It is a monthly moving average of daily data. The moving period allows the estimation to change over time. Thus, the estimation may reflect the recent prediction of the market. On the other hand, the moving period prevents the estimation from over fluctuation due to the frequent absence of the trading of Leaps. Leaps do not have high liquidity. A Leap, with certain maturity and exercise price, may not be traded for days, weeks, even months and then comes back to the market. The Leaps traded today are often different from those traded yesterday in exercise price or maturity. Since different Leaps would give different implied standard deviations, daily average, even

weekly average, may have high fluctuation. Monthly moving average is more stable.

TABLE 8
IMPLIED VS. STATISTICALLY ESTIMATED
DEVIATIONS OF STOCK RETURN

Company	Weighted Average Implied Standard Deviation	Statistically Estimated Standard Deviation	Difference
General Motors	0.3802	0.3937	-0.0135
Kmart	0.3590	0.3445	0.0145
Texas Instruments	0.4116	0.4174	-0.0058
RJR Nabisco	0.3733	0.4133	-0.0400
Tenneco	0.3540	0.3306	0.0234
Sears Roebuck	0.2887	0.3139	-0.0252
Westinghouse	0.3370	0.5356	-0.1986
Citicorp	0.4079	0.4070	0.0009
Test	Correlation coefficient: 0.2551		H_0 : Mean=0 t-value = -1.22

Latane and Rendleman compared their implied standard deviations with the statistically estimated standard deviations. They found their implied standard deviations were highly correlated with the statistically estimated standard deviations. They regarded the high correlation as evidence that gives credit to the methodology. Table 8 compares the cross-time average of the implied standard

deviations given by (46) and the statistically estimated standard deviation over the test period, which is the σ_1 , used in (44), for each of the eight companies. The correlation between the two standard deviations is not high but the t-test indicates no significant difference between them. With such a small sample, however, the implication of the results is limited.

The implied standard deviation σ_1 depends on the prices of Leaps. The predicted value of the call option in Percs C_1 is linked to the prices of Leaps by σ_1 . If σ_2 is used in (45), such linkage will not exist. Since the major concern of this research is the relative price of Percs with respect to the relevant securities, C_1 should be evaluated with σ_1 rather than σ_2 .

The Results of Tests on Price Parity

With C_1 , $V_1(D_1)$ and $V_1(D_2)$ being evaluated, the predicted value of Percs can be computed by (7) and the test on Hypothesis V is ready to be conducted. Figure 19 through Figure 26 in Appendix III exhibit the predicted values and market prices of the eight Percs. Two of the eight Percs, namely General Motors and Westinghouse, had market prices that kept above the predicted values. The other six, Kmart, Texas Instruments, RJR Nabisco, Tenneco, Sears and Citicorp, had market prices that occasionally went below the predicted

values. The vertical distance between the market price and the predicted value tends to decline over time for most Percs.

Table 9 in Appendix IV presents the results of the tests on Hypothesis V. The null hypothesis is rejected for seven out of the eight companies at either one percent or five percent significance level. Notice the eight means of δ and the corresponding t-values are all positive. If the null hypothesis H_0 is reset as $E\{\delta\} \leq 0$ and the alternative hypothesis H_1 as $E\{\delta\} > 0$, the null hypothesis will also be rejected for the seven companies at one or five percent significance level. Such results indicate that the Percs were overpriced with respect to the package composed of common stock and call option. The overpricing is statistically significant for seven of the eight Percs. The relative size of overpricing ranges from 0.03 percent to 10.67 percent.

The evaluation of C_1 is crucial to the evaluation of Percs. If C_1 is poorly evaluated, the predicted value of Percs cannot be a good benchmark. One way to examine whether the call option in Percs has been fairly evaluated is to check the correlation between C_1 and the market price of the Leap which is close to C_1 in exercise price and maturity. If the call option is fairly evaluated, C_1 will have high correlation with the market price of the Leap. A

low correlation between C_1 and the Leap might indicate that the evaluation of the call option is not good.

Table 10 lists the correlations between C_1 and the closest Leap. All the correlations are equal to or above 0.90. The high correlations suggest that the evaluation of C_1 by the Black-Scholes Model is in agreement with the evaluation of Leaps by the market.

TABLE 10
CORRELATION BETWEEN
CALL OPTION IN PERCS AND THE CLOSEST LEAP

Company	Call in Percs vs. Leap (Cap/Exercise price, Maturity date)	ρ	N
GM	(\$53.79,940701) vs. (\$50.00,950121)	0.92	153
Kmart	(\$57.20,940915) vs. (\$55.00,950121)	0.90	30
TI	(\$38.74,941101) vs. (\$40.00,950121)	0.99	45
RJR	(\$13.70,941115) vs. (\$12.50,950121)	0.98	147
Tenneco	(\$42.75,941231) vs. (\$45.00,950121)	0.93	36
Sears	(\$59.00,950401) vs. (\$55.00,950121)	0.92	24
Westing -house	(\$23.80,950901) vs. (\$22.50,950121)	0.91	165
Citi- corp	(\$20.28,951130) vs. (\$20.00,950121)	0.98	45
<p>ρ: correlation coefficient. N: number of observations. Maturity date: YMMDD.</p>			

A direct comparison between C_1 and the market price of the closest Leap gives another examination on the evaluation

of the call option. Figures 27 through 34 of Appendix V provide such a comparison. Each of the figures in Appendix V exhibits the estimated value of C , and the market price of the closest Leap for one firm. The density of the points on the line depends on the number of daily prices available to the closest Leap. For example, the lines in Figure 27 are composed of many points which are close to each other, because the Leap closest to the call option in General Motors Percs was frequently traded. In contrast, the points on the lines in Figure 28 are far away from each other, because the Leap closest to the call option in Kmart Percs had a low frequency of trading.

Figures 27 through 34 show that the estimated values of the call options in Percs were generally moving along with the prices of their closest Leaps. That was also revealed by the correlation analysis in Table 10. It would be interesting to look at whether the predicted value of the call option in Percs kept its relationship with the price of the closest Leap in accordance with the principles of option pricing.

According to the principles of option pricing (see Merton 1973), a call option with a larger exercise price and a shorter maturity has less value than a call option with a smaller exercise price and longer maturity. Three call options in Percs have larger exercise prices and shorter

maturities than their closest Leaps. They are General Motors', Kmart's and RJR Nabisco's. See Table 10. Two of them, General Motor and RJR Nabisco, followed the principles of option pricing quite well. Their predicted values were consistently below the prices of the closest Leaps. Kmart did not follow the principles of option pricing as strictly as General Motors and RJR Nabisco. The predicted value of the call option in Kmart Percs went above the price of the closest Leap twice. Except the two violations, the overall relationship between the call option in Kmart Percs and the closest Leap, as shown in Figure 28, is still consistent with the principles of option pricing.

The relationship between the call option in Percs and the closest Leap is not as clear-cut for the remaining five companies. Sears, Westinghouse and Citicorp's call options in Percs had higher exercise prices but longer maturities than the closest Leaps. Higher exercise prices reduce while longer maturities increase the value of call options. Therefore, it is not clear whether the three call options in Percs were more or less valuable than their closest Leaps. Similarly, Texas Instruments and Tenneco's call options in Percs had lower exercise prices and shorter maturities than the closest Leaps. Lower exercise prices increase the value of call options while shorter maturities reduce the value of call options. With contradictory effects of exercise price

and maturity, the principles of option pricing cannot predict whether the two call options should be more or less valuable than their closest Leaps. However, with a close look at each of the five pairs of the call option in Percs and the closest Leaps, one can find that the principles of option pricing still provide clues of the appropriateness of the option evaluation.

For Tenneco, the maturity dates of the call option in Percs and the closest Leap are pretty close, December 31, 1994 vs. January 21, 1995. With lower exercise price, the call option should have greater value than the Leap. In Figure 31, the predicted value of the call option, as suggested by the principles of option pricing, is higher than the price of the Leap.

For Citicorp, the exercise prices of the call option in Percs and the closest Leap are quite close, \$20.28 vs. \$20.00. With about a two-month longer maturity, the call option should be more valuable than the Leap. In Figure 34, the predicted value of the call option is above the price of the Leap with only one exception.

For Westinghouse, the exercise price of the call option in Percs is one dollar higher than that of the closest Leap while the maturity is seven months longer. The opposing effects of the higher exercise price and the longer maturity could be roughly offset so that the value of the call option

could be near the value of the Leap. In Figure 33, the predicted value of the call option goes together with the price of the Leap. It is still in agreement with the principles of option pricing.

For Texas Instruments, the exercise price of the call option in Percs is one dollar lower than that of the closest Leap while the maturity is about three months shorter. The effect of the shorter maturity offsets part of the effect of the lower exercise price. The value of the call option should be a little greater than that of the Leap. In Figure 29, the predicted value of the call option is a little higher than the price of the Leap, conforming the principles of option pricing.

For Sears, the exercise price of the call option in Percs is four dollars higher than that of the closest Leap while the maturity is just two months longer. The effect of exercise price should dominate the effect of the maturity and the value of the call option should be significantly smaller than that of the Leap. However, Figure 32 shows the predicted value of the call option tends to be higher than the price of the Leap. That is a diversion from the principles of option pricing.

In summary, the predicted values of the call options in Percs are comparable with the market prices of Leaps and the relationships between them are consistent with the

principles of option pricing with few exceptions. Most of the call options in Percs seem to be properly evaluated and the observed overpricing of Percs is not due to any serious mis-evaluation of the call options.

The Results of Tests on Arbitrage Restrictions

Since all the means of δ s came out to be positive in the tests on Hypothesis V, it looks quite obvious that the opportunities of arbitrage by longing Percs and shorting common could hardly exist. Therefore, the tests on Hypothesis VI is of little meaning and thus omitted.

The best feasible Leaps that can be used in the long-common-short-Percs arbitrages are listed in Table 11, one for each of the eight companies. Five of them, Kmart, Texas Instruments, Tenneco, Westinghouse and Citicorp, meet the requirements of the long-common-short-Percs arbitrage, with exercise prices higher and maturities shorter than that of the call option in Percs. The five companies may have more than one Leap that meets the long-common-short-Percs requirements. If a company has more than one Leap that meet the requirements, the Leap that is closest to the call option in Percs was selected for the test. The Leaps of the remaining three companies in Table 11 do not meet both the requirements of long-common-short-Percs arbitrage. Their exercise prices are lower than the exercise prices of the

TABLE 11
THE BEST FEASIBLE LEAPS FOR
LONG-COMMON-SHORT PERCS ARBITRAGES

Company	Leap (Exercise price, Maturity date)	Call in Percs (Cap, Maturity date)
GM	(\$50.00, 940121)	(\$53.79, 940701)
Kmart	(\$60.00, 940121)*	(\$57.20, 940915)
TI	(\$40.00, 940121)*	(\$38.74, 941101)
RJR	(\$12.00, 940121)	(\$13.70, 941115)
Tenneco	(\$45.00, 940121)*	(\$42.75, 941231)
Sears	(\$55.00, 950122)	(\$59.00, 950401)
Westinghouse	(\$25.00, 940121)*	(\$23.80, 950901)
Citicorp	(\$22.50, 950122)*	(\$20.28, 951130)
* Meets the requirements of long-stock-short-Percs arbitrage, i.e., the exercise price is higher and the maturity is shorter than that of the call in Percs.		

call options in Percs, although their maturities are shorter than the maturities of the call option in Percs. The reason that they were selected for the tests is that the three companies, General Motors, RJR Nabisco and Sears, did not have any Leaps that meet both the requirements of the long-common-short-Percs arbitrage. The three Leaps may have greater instead of smaller values than the corresponding calls in Percs because of the lower exercise prices. They might move the upper bound of no-arbitrage interval P_{U_1} down rather than up. The lower upper bound will make it more difficult to reject the null hypothesis, $E\{\mu_{U_1}\} \geq 0$, and

thus enhance the reliability of the result in case the null hypothesis is still rejected.

Transaction costs of the arbitrage, as discussed before, are composed of commissions, bid-ask spreads and costs resulted from short selling restrictions. Commissions vary with the size of trading and the intermediary. Table 12 lists three ranges of commissions and their sources. The top of the range indicates the commission on small trades with service brokers while the bottom indicates the commission on small trades discount brokers. Negotiable rates were not considered. The commission schedules are effective to typical investors. Special figures like market makers might not pay commissions, but they have other type of costs.

TABLE 12
RANGES OF COMMISSIONS

Source	Common Stock	Call Option
Chance (1989) pp.49-50	1.00-2.00%	1.10-2.40%
Cox, Rubinstein (1985) p.110	0.45-8.40%	0.87- 100%
Smith, Profitt (1992) p.67, p.540	0.46-2.52%	0.68- 60%
Note: All commissions are measured as percentage of dollar volume of trading. Negotiable rates are not included.		

By definition, a bid-ask spread is simply the difference between the ask price and the bid price. The estimation of the spread is far more complicated than what the definition looks like. First, bid and ask quotes are not available on those convenient resources. The data of bid and ask prices can be expensive. Second, even with bid and ask quotes in hand, the spread might be difficult to estimate. Roll (1984) points out that the difference between the bid and ask quotes is not a good measure of the spread because "the actual trading is done mostly within the quotes". He designed an "implicit measure" of the effective bid-ask spread. The method does not need bid-ask quotes. It estimates the effective spread by using just prices. Besides, Roll's model is simple and easy to apply. That makes the method attractive. Although empirical tests show evidence supporting Roll's method of estimation bid-ask spreads, the estimates generated by the method created anomaly. The model implies that the spread should be independent of the measurement interval length. However, sizable difference exists between the spread estimated from daily data and that from weekly data. Such findings raises questions as to the reliability of Roll's method. Further efforts on the estimation of bid-ask spread were made by Stoll (1989), Chang and Chang (1993), and a number of others. In order to overcome the discrepancy in Roll's

figures, other researchers developed more sophisticated models. As the models becomes more and more sophisticated, the applications of the models becomes more difficult.

Since the test of arbitrage, as discussed before, will use only the minimum transaction costs, it is possible to avoid the complicated estimation procedures of bid-ask spread. Under the rule of the exchange, security prices can move only in tick increments. Thus, a tick is the minimum price movement of a security permitted by the exchange. Both bid and ask prices are supposed to follow the rule, therefore the difference between them cannot be smaller than a tick. For stocks listed in the New York Stock Exchange, including Percs, a tick is normally 1/8 dollar (\$0.125). For Leaps, a tick can be 1/8 or 1/16 dollar (\$0.125 or \$0.0625).

Suppose the arbitrageur pays the lowest commission rates in Table 12, and bears half a tick as the cost due to the spread. Then γ_s and γ_p equal 0.45% while $\lambda_s S_t$ and $\lambda_p P_t$ equal \$0.0625, which is half of \$0.125. Similarly, γ_L would equal 0.68% and $\lambda_L L_t$ would equal to \$0.0625 or \$0.03125, depending on whether the tick of the Leap is 1/8 or 1/16.

The loss of interest due to short selling restrictions equals $\exp(r_R T_t) P_t - P_t$. The present value of the loss is

$$\exp(-r_R T_t) (\exp(r_R T_t) - 1) P_t = (1 - \exp(-r_R T_t)) P_t.$$

Therefore,

$$\theta = 1 - \exp(-r_R T_i). \quad (47)$$

The transaction costs at the end of arbitrage, the q in (29) and (32), is uncertain. This q would be relatively small compared to the other terms in (29) and (32) because it is subject to a product of two small figures, a discount factor and a probability. Ignoring the costs at the end of arbitrage would cause the total transaction costs to be even smaller than Q_{U_i} , the minimum transaction costs as defined in (29) and (32), and induce bias in the results of the tests. However, such bias would enhance the reliability of the result in case the null hypothesis is rejected, since it makes the null hypothesis more difficult to be rejected.

Table 13 in Appendix VI shows the results of the tests on Hypothesis VII, in which the transaction costs at the end of the arbitrage were ignored while other transaction costs were estimated at the minimal level. The means of the μ_U 's are all negative. Seven of them are significant while one, General Motors, is insignificant. The null hypothesis can be rejected at the one percent significance level for all the companies except General Motors. The significance level would be higher than what appears in Table 13 for General Motors, RJR Nabisco and Sears if the exercise prices of the Leaps were not lower than that of the call options in Percs. Notice that the exercise price of General Motors' Leap is

much lower than that of the call option in Percs (\$50.00 vs. \$53.79). The significance level could be considerably higher and the null hypothesis might have been rejected if the Leap had the same exercise price as the call option in Percs. Since General Motors does not have any Leaps that meet the requirements of the long-common-short-Percs arbitrage, the test has to be left inconclusive.

The results of the tests on Hypothesis VII indicate that arbitrages by longing common and shorting Percs could hardly be profitable, although Percs were significantly overpriced as shown in the tests on Hypothesis V. Transaction costs, together with the unmatchable call option in Percs prevented arbitrages from being profitable.

Among the various transaction costs, the costs due to short selling restrictions played the major role in the prohibition of arbitrage. Table 14 lists the dollar amounts and the proportions of the three transaction cost components that have been applied in the tests of the arbitrage restrictions. The costs due to short selling restrictions has the highest proportion of the total costs. It is even larger than the sum of the other two components. The short selling restriction costs composed the main barrier to the arbitrage profit, at least as the Percs was still distant from its maturity.

TABLE 14
COMPONENTS OF TRANSACTION COSTS

Company	Commission	Bid-Ask Spread	Short Sale Restriction
General Motors	\$0.37 (14%)	\$0.19 (7%)	\$2.19 (79%)
Kmart	\$0.47 (18%)	\$0.19 (7%)	\$1.96 (75%)
Texas Instruments	\$0.38 (18%)	\$0.19 (9%)	\$1.58 (73%)
RJR Nabisco	\$0.09 (12%)	\$0.19 (24%)	\$0.52 (64%)
Tenneco	\$0.35 (16%)	\$0.19 (9%)	\$1.64 (75%)
Sears	\$0.41 (13%)	\$0.19 (6%)	\$2.61 (81%)
Westinghouse	\$0.13 (9%)	\$0.19 (14%)	\$1.08 (77%)
Citicorp	\$0.20 (12%)	\$0.19 (12%)	\$1.22 (76%)
<p>Note: The dollar amount of each item is an over-time average of the cost component. The percentage in parenthesis is the proportion of that component in the total transaction costs, which is also an over-time average.</p>			

The relative size of the costs due to short selling restrictions might have been exaggerated. Notice that bid-ask spreads and commission rates were set at the lowest level in the tests. The actual proportions of bid-ask spread and commissions in the total transaction costs could be larger than that in Table 14 while the actual proportion of the costs due to short selling restrictions could be smaller.

Discussions

Why were Percs overpriced? It could be due to something that is contributed by Percs and valued by investors.

In his 1984 presidential address to the American Finance Association, James C. Van Horne (1984) argues that a truly innovative financial instrument "must make the market more efficient in an operational sense or more complete". For companies with Leaps listed, Percs is more like a duplicate of existing securities than a new security. It does not make the market more complete. For companies without Leaps listed, the call option in Percs is new with regard to the length of maturity as well as the level of exercise price. However, an extension of option maturity and exercise price does not necessarily make the market more complete. Theoretically, any payoffs contingent on the price of a common stock can be replicated by portfolios made up of the common stock and a riskless bond. Therefore, securities derived from common stocks would be redundant in the sense of market completeness.

The contributions of Percs are more likely in the operational efficiency of the market. Packing the "buy-write" strategy into one security, Percs may save transaction costs. To set up a "buy-write" position by longing a share of common stock and short selling a call

option, an investor needs to pay for transaction costs as much as $\gamma_s S + \lambda_s S + \gamma_c C + \lambda_c C$. With Percs, he needs to pay only $\gamma_p P + \lambda_p P$. The difference is

$$(\gamma_s S + \lambda_s S + \gamma_c C + \lambda_c C) - (\gamma_p P + \lambda_p P), \quad (48)$$

where the notations are following those in the last section. Suppose $\gamma_s = \gamma_p$ and $\lambda_s = \lambda_p$. When the Percs is issued, $P = S$. The amount of transaction costs to be saved is $\gamma_c C + \lambda_c C$.

Formula (48) includes only the transaction costs at the beginning of the position holding period. By the end of the period, there can be more costs for the investor who made up the position with common stock and call options, as the call option is in the money. If the position is made up of Percs, it will automatically turn into a long position of common stock without any costs, no matter whether the common price is above or below the cap. The transaction costs that Percs can save for the "buy-write" player could be more than that in (48).

Furthermore, Percs may help investors save costs of dynamic hedging. Jarrow and O'Hara (1989) argue that "the long-term option created by the Score avoids the cost of replicating such an option via dynamic hedging, causing the Score to be more valuable than predicted by a standard option pricing model." This argument also applies to Leaps although Leap did not yet exist when the article was

published. After Leaps were created, investors can use Leaps to do long term hedging when the company involved has Leaps listed. But investors probably have difficulty finding enough Leaps with long enough maturity. Leaps with a two to three-year maturity have low liquidity and small volume of open interests. As the sample sizes in Table 10 and Table 13 indicate, the Leaps with maturities and exercise prices close to the call options in Percs are absent for many trading days. The supply of Leaps, or short positions of Leaps, may not be enough to meet the demand. Considering the number of short positions of call options supplied in an issue of Percs, which amounts to hundreds thousand of contracts, one can hardly imagine whether they would have ever been absorbed by the market if the issuing company had not taken the long positions against them. Percs provided a way to meet the demand for short positions of call options which had not been satisfied by existing securities. Percs may contribute to the reduction of transaction costs caused by dynamic hedging even though they came out as just duplicates of existing securities.

In Miller's (1986) opinion, regulations and taxes, instead of transaction costs and market completeness, are the major impulse for financial innovation over the past twenty years. "... modern finance theory assures us, as practitioner have long known, that securities can be used to

transmute one form (or use or recipient) of income into another -- in particular, higher taxed form to lower taxed ones." Does Percs transmute any income from one form to another? Yes, it transmutes option premium to dividends. When a "buy-write" player writes a call option, he receives a premium. If he buys Percs, he is going to be compensated by extra dividends. Individual investors might prefer premiums to dividends, because the tax on premiums can be postponed. Institutional investors, in contrast, would prefer dividends to premiums. For them, call option premiums are subject to income tax without exclusion while the dividends of Percs qualify for a 70 percent intercorporate dividend-received deduction (see prospectus of Percs). This difference in the tax treatment explains why Percs have been sold predominantly to institutional accounts (see Pratt, June 8, 1992, November 4, 1991, etc.). Institutional investors might be able to bypass considerable amounts of tax liabilities with the help of Percs.

In brief, Percs may have advantages in both taxes and transaction costs over the combination of the separate common stock and short position of call option. That could be the reason why Percs were overpriced with respect to the package composed of the common stock and the short position of the call option.

CHAPTER V

MARKET REACTION TO PERCS OFFERING VS. MARKET REACTION TO COMMON OFFERING

As reviewed in Chapter II, there are four major explanations about the negative market reactions to common stock offerings, wealth redistribution hypothesis, price pressure hypothesis, information release hypothesis and agency problem hypothesis. Each of them may have its own implication on the market reaction to Percs offerings.

The wealth redistribution hypothesis implies that the market reaction on Percs offerings should be similar to that on common stock offerings. Like common stocks, Percs are full-credit equity. The issue of Percs will reduce the debt ratio just as the issue of common stock. If the increased amount of common stock causes wealth transfer, so will the newly issued Percs.

The price pressure hypothesis would give different implications to Percs issue than it does to common issue. The issue of Percs may add less pressure on the common price than the issue of common itself, because part of the Percs could go to the market segments other than that of the common stock. As the two architects of Percs once pointed out, Percs are designed for investors who are looking for

enhanced cash flows while common stocks are more attractive to those who prefer potential capital gains. As part of the Percs are absorbed by investors other than the typical common stock investors, price pressure on the common stock is relieved.

The information release hypothesis assumes that firms would issue common stocks when their stocks are overvalued because managers would use their inside information to promote current shareholders' interest. Thus, the issue of common stock could be perceived by investors as a signal that the stock is overvalued. For the same reason, a common stock would be undervalued if the firm repurchases it. The issue of Percs approximates to a combination of selling common stock and buying call option on the stock. Buying call option can be considered a kind of repurchasing common stock. Thus, the issue of Percs gives a mixed signal.

Differential (7) with dividends held constant:

$$dP_t = dS_t - dC_t \quad (49)$$

Suppose the common is overvalued by dS_t . Then, the call option will be overvalued by dC_t . dC_t should be less than dS_t , therefore $dP_t > 0$ and $dP_t < dS_t$. The Percs is also overvalued but less than the common is. After all, the signal carried by the issue of Percs tends to be that the underlying common is overvalued but it would be weaker than the signal conveyed by the issue of common stock.

The agency model would also predict a weaker market reaction on the issue of Percs compared to the market reaction on the issue of common stock. Although the issue of Percs will ultimately increase the number of shares outstanding due to the mandatory conversion requirement, the cap will limit Percs holders' participation in the firm's potential. The issue of Percs could reduce the management percentage shareholdings, but not as much as common stock does. The agency costs induced by Percs issue would be smaller than that by common issue. The market reaction on Percs issue should be weaker than that on common issue.

All of the four hypotheses predict that the market would react negatively to the issue of Percs, but the wealth redistribution hypothesis implies no difference between the market reactions to Percs offerings and common offerings while the other three hypotheses suggest the reaction to Percs offerings would be weaker than that of common offerings.

CHAPTER VI

EVENT STUDY ON PERCS OFFERINGS

To examine the market reaction on Percs offerings, this event study applies the market model:

$$R_{jt} = \alpha_j + \beta_j R_{mt} + e_{jt} \quad (50)$$

In (50), R_{jt} is the rate of return to stock j on day t , R_{mt} is the rate of return to the market index on day t , and e_{jt} is the error term of stock j on day t .

Define abnormal return of stock j on day t as

$$AR_{jt} = R_{jt} - a_j - b_j R_{mt} \quad (51)$$

where a_j and b_j are ordinary least square estimates of α_j and β_j in (50).

The cumulative abnormal return for N_c days is

$$CAR_j = \sum_{t=1}^{N_c} AR_{jt} \quad (52)$$

Standardize the cumulative abnormal return by the estimated standard deviation S_j :

$$SCAR_j = CAR_j / S_j \quad (53)$$

where

$$S_j = \left(s_j^2 \left[N_c + \frac{N_c^2}{N_e} + \left(\sum_{t=1}^{N_c} R_{mt} - N_c \bar{R}_m \right)^2 / \sum_{t=1}^{N_e} (R_{mt} - \bar{R}_m)^2 \right] \right)^{1/2} \quad (54)$$

and

s_j^2 = residual variance for stock j from the market model regression,

\bar{R}_m = average rate of return on the market index during the estimation period,

N_e = the number of days in the estimation period,

N_c = the number of days in the cumulative event period.

The test statistics, Z , for a portfolio of J securities over the event period is

$$Z = \left(\sum_{j=1}^J SCAR_j \right) / \sqrt{J} \quad (55)$$

which approximately has a standard normal distribution.

Both the announcement day and the issue day were selected as event days. Denote an event day as Day 0. The estimation period includes three hundred days from Day -360 to Day -61.

The announcement day is the day when the news of a Percs offering appeared on The Wall Street Journal first time, which is usually a report about the firm's filing of Percs with SEC. The issue date is recorded on the prospectus.

The sample for the test of announcement includes all the firms listed in Table 1 except Avon, Chiquita and RJR Nabisco, with the size equal to 13. The reason that the three firms were excluded from the sample is information

contamination. Avon's Percs offer was announced with a common shares exchange offer and a divesting plan. Chiquita's Percs were also offered to exchange common shares. RJR's announcement was composed of a common stock offer besides the Percs offer.

Avon and Chiquita were also dropped from the sample of the test on issue date because they are exchange offers. An exchange offer can be considered as a combination of a Percs offer and a common stock repurchase offer. The effect of common repurchase can be contrary to that of Percs issue and may contaminate the test result. Thus, the two firms were excluded. The sample for the test on issue date has 14 Percs which were all offered for cash.

The data were taken from CRSP tape 1992 version NYSE/AMEX daily return file. The value weighted CRSP index was used as an approximation of market index.

Table 16 in Appendix VII exhibits the average abnormal returns around the announcement day of Percs offering. On Day 0, the announcement day, the average abnormal return is not significant while on Day -1, the previous day of announcement, it is -1.18 percent and significant at five percent level. The average cumulative abnormal return over Day -1 and Day 0 is -0.52 percent and insignificant but the average CAR over Day -2 and Day -1 is -1.75 percent and significant at five percent level. The average CAR over

Day -3 to Day -1 is also significant. It seems that some information about Percs offerings or information of some Percs offerings was released two or three days before the reports appeared on the newspaper. Investors might have access to the information about filings with SEC other than the newspaper. When the report about the filing came out from the newspaper, the market reaction appeared to be already over.

Compared with the cumulative abnormal return over the announcement period of common stock offering, the average two-day CAR of Percs offering is smaller. The average two-day CAR of common offering around the announcement is -3.14 percent (see Smith 1986) while the average two-day CAR of Percs offering is -1.75 percent. The market reaction to Percs offering is approximately half strong as that to common offering. This result supports the price pressure hypotheses, the agency problem hypothesis and the signaling hypothesis but not the wealth redistribution hypothesis.

Table 17 in Appendix VII exhibits the average abnormal returns around the issue date. The abnormal return on Day -1 is -1.68 percent and significant at one percent level. The two-day cumulative abnormal return over Day -1 to Day 0 is -1.93 percent and also significant. It is roughly the same in size as the two-day CAR upon the initial announcement.

The market reaction on the issue date indicates that the issue of Percs conveys information that is not contained in the announcement of Percs issue. Such information can include the size of the extra dividend, the level of the cap, etc. Usually, those Percs issue terms are not available in the initial announcement.

It seems that the information passed by Percs issue terms was not favorable. Otherwise, the market would not react negatively around the issue date. The level of the cap and the size of the abnormal dividend would imply the firm's expectation about its own volatility. If the expected volatility revealed by the terms of Percs is higher than the average expectation, the common stock price could go down.

Part of the negative market reaction around the issue date might be due to the extra volume of the issue. Table 15 gives several companies' projected and actual Percs issue volumes. A number of those companies issued more Percs than the volume announced in the filing with SEC. The extra volume could cause, as price pressure hypothesis suggests, extra pressure on the price of common stock or, as agency model implies, further reduction in management percentage shareholdings. If the extra issue volume is unexpected, it can press the common price down. However, The extra volume of the issue should not be the main reason

for the market reaction on the issue date. The size of the extra volumes, except Citicorp's, are small compared to the projected volumes. They could not stimulate market reaction to such an extent. The two-day CAR around the issue date is approximate to that around the initial announcement. The information revealed by the terms of Percs should have a role in the market reaction on the issue day.

TABLE 15
PROJECTED AND ACTUAL ISSUE VOLUMES OF PERCS

Company	Projected Volume	Actual Volume	Difference (%)
General Motors	16.0	15.5	- 3.7%
Kmart	15.0	23.0	+53.3%
Texas Instruments	8.0	10.5	+31.3%
Broad	6.0	6.0	0.0%
Sears	25.0	25.0	0.0%
Westinghouse	26.0	28.6	+10.0%
Citicorp	32.5	68.0	+109.2%
Note: The unit of volume is the million shares.			

The results in Table 16 and 17 are not the same as Finnerty's (November 1993). Finnerty also found a significantly negative market reaction to the announcement of Percs offering, but his two-day abnormal return is

-0.532 percent, much smaller than that of this research. In addition to the market reaction upon the offering announcement, Finnerty tested the market reaction to the announcement of issue terms. The period of issue term announcement was defined as "the trading day the announcement of the terms of the Percs issue appeared in The Wall Street Journal together with the preceding trading day." It is not clear whether the announcement day of Percs issue terms is the same as the Percs issue day. The test result shows a negative but insignificant impact of the issue term announcement. It implies "that the announcement of the new issue terms does not convey any incremental useful information to the marketplace."

The difference between the results of this research and Finnerty's may be due to a number of reasons. One is the difference in sample. Finnerty's test sample has eleven firms including RJR Nabisco. My sample for the test of initial announcement has thirteen firms with RJR Nabisco excluded while my sample for the test on issue date has fourteen firms with RJR Nabisco included. The methodologies are also different between the two researches. Finnerty took Brown and Warner's approach (1980). My research followed Mikkelson and Partch's approach (1988). With such small sample size, a few more observations and a switch in methodology could cause a significant difference in the

results. After all, both researches are conducted with small samples. Therefore, both of the results should be regarded tentative.

CHAPTER VII

SUMMARY

This dissertation analyzed Percs in two aspects, the price parity of Percs with the relevant securities and the impact of the Percs offering on the price of common stock.

The analysis of price parity shows that a share of Percs is equivalent to a package that is composed of a common stock, a short position of call option and an annuity. The tests on the price parity revealed that Percs were overpriced with respect to the equivalent package. Further tests on arbitrage restrictions indicate that arbitrage opportunities barely existed. It was transaction costs, together with the unmatched exercise price and maturity of the call option in Percs, that prevented arbitrage from being profitable. Among the transaction costs, the costs due to short selling restrictions played a major role.

The overpricing of Percs is an evidence of its contributions. Percs may help investors reduce transaction costs and tax costs. The contributions are valued by investors. The companies which issue Percs may share the benefits.

An event study on the issue of Percs shows that the market reaction to the issue of Percs was significantly negative both around the announcement day and around the issue day. The observed market reaction to the announcement of Percs offering is much less than that to the announcement of common stock offering. As an alternative way to raise equity, Percs might be a better choice for those companies which are eager for equity but reluctant to issue common stocks. Compared to the issue of common stock, the issue of Percs may add less pressure on the price of common stock, induce less agency costs and have less signaling effects.

In addition to the impact on common stock price during the announcement period, a Percs offering may have another impact on common price during the issue period. Issue terms like the amount of extra dividends and the level of the cap seem to convey information.

By Von Horne's and Miller's standards, Percs can be regarded as an innovative security. Its hybrid structure may help investors reduce transaction costs and tax costs. Besides, it may help companies to solve their financial problems.

APPENDIX I

PRICES OF COMMON STOCK AND PERCS

?

FIGURE 3

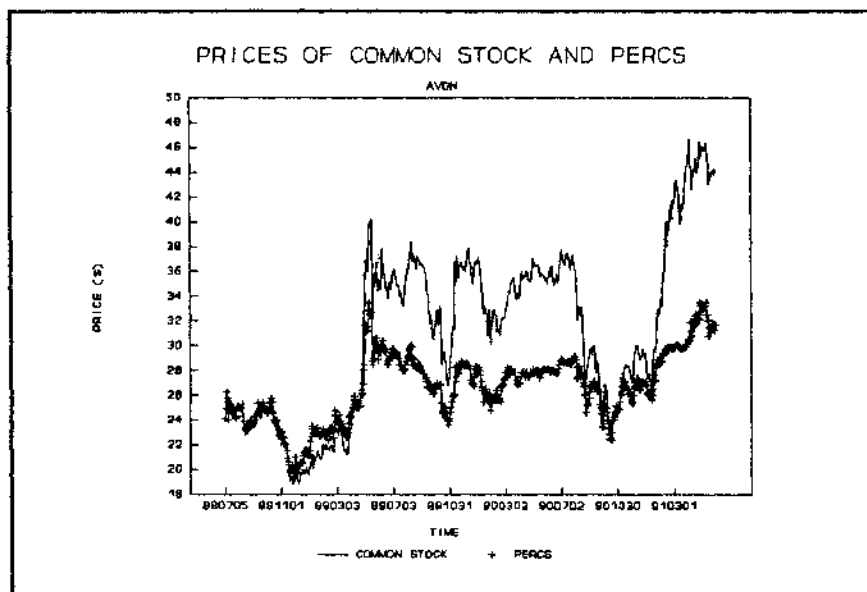


FIGURE 4

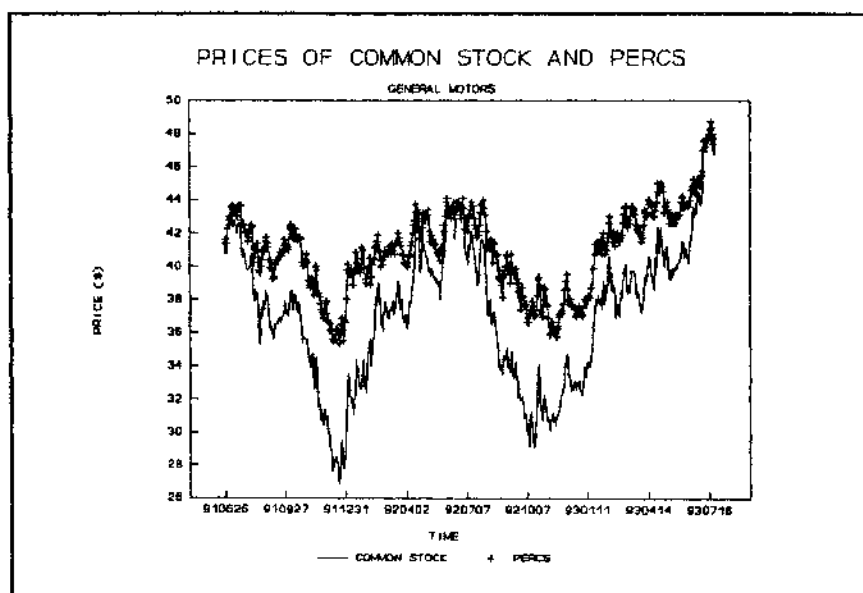


FIGURE 5

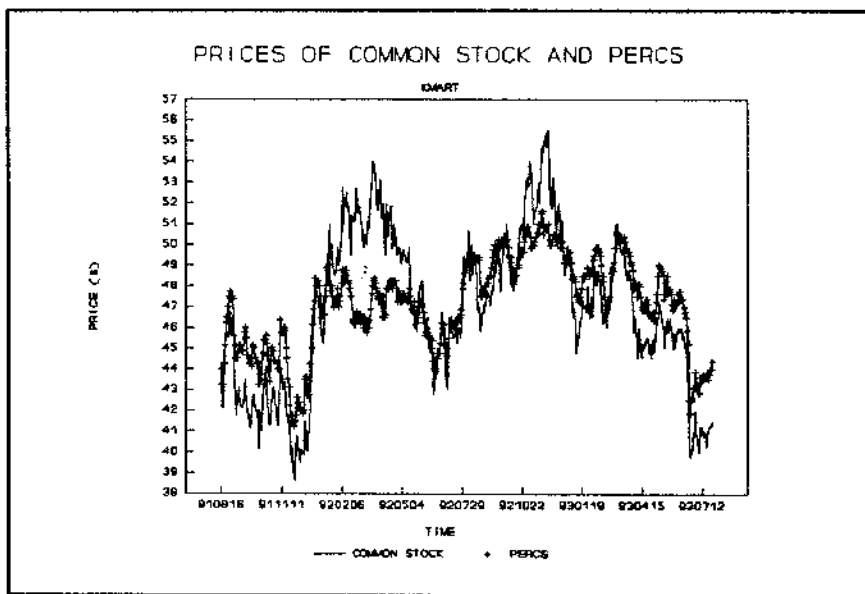


FIGURE 6

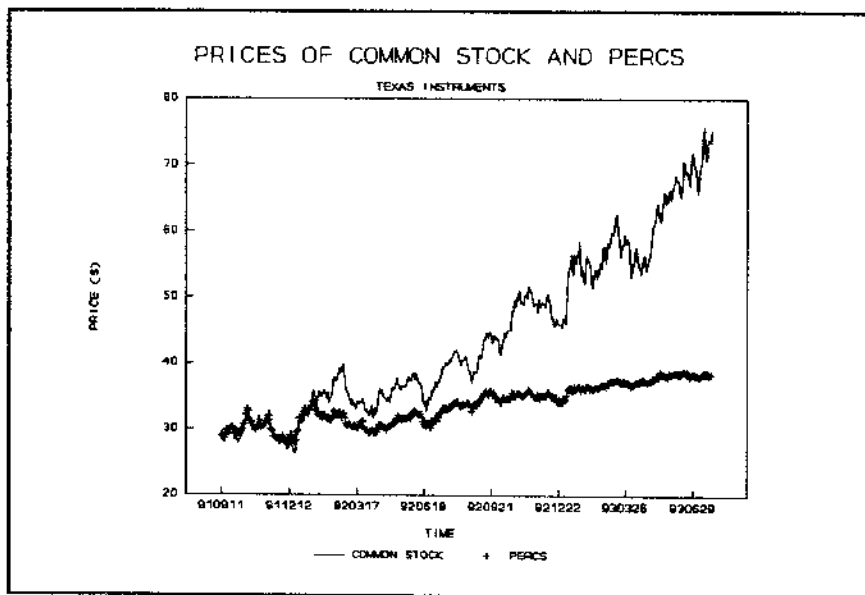


FIGURE 7

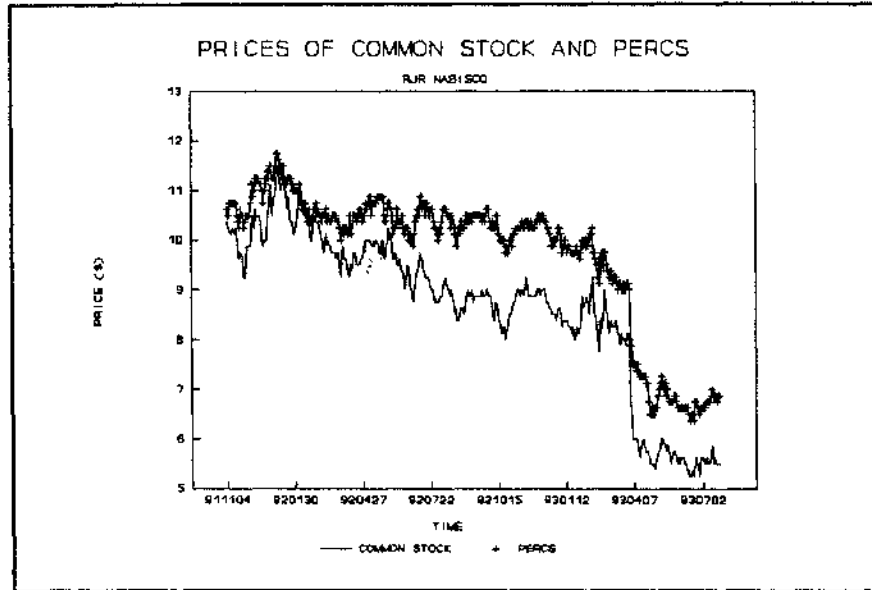


FIGURE 8

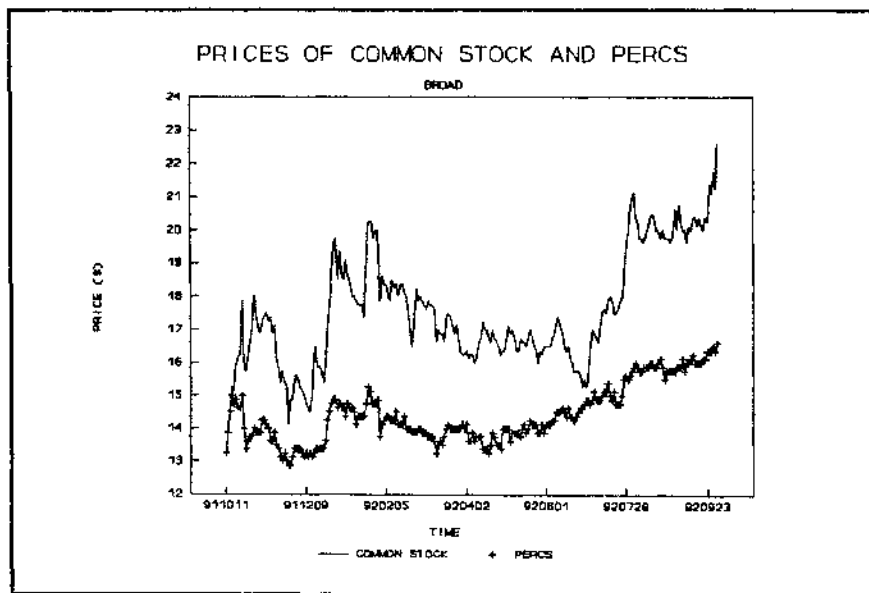


FIGURE 9

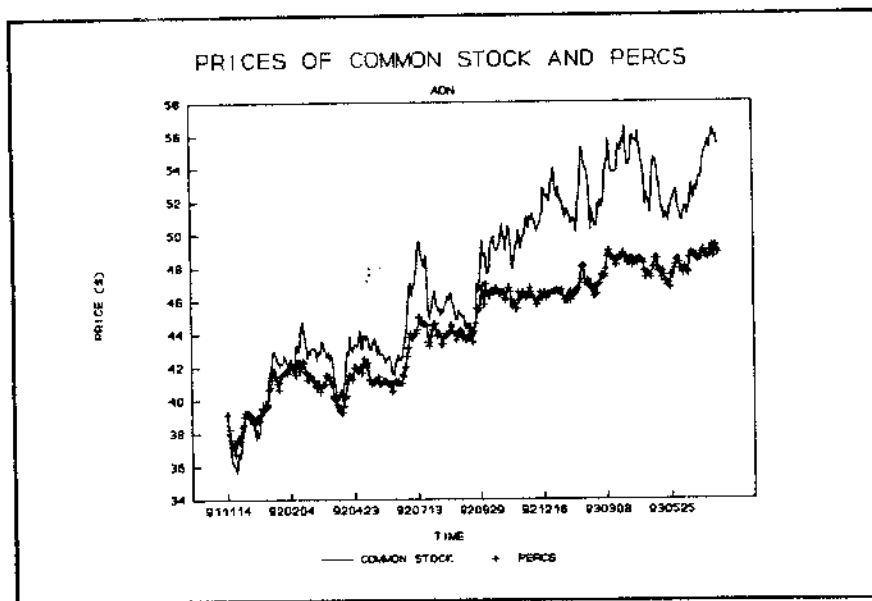


FIGURE 10

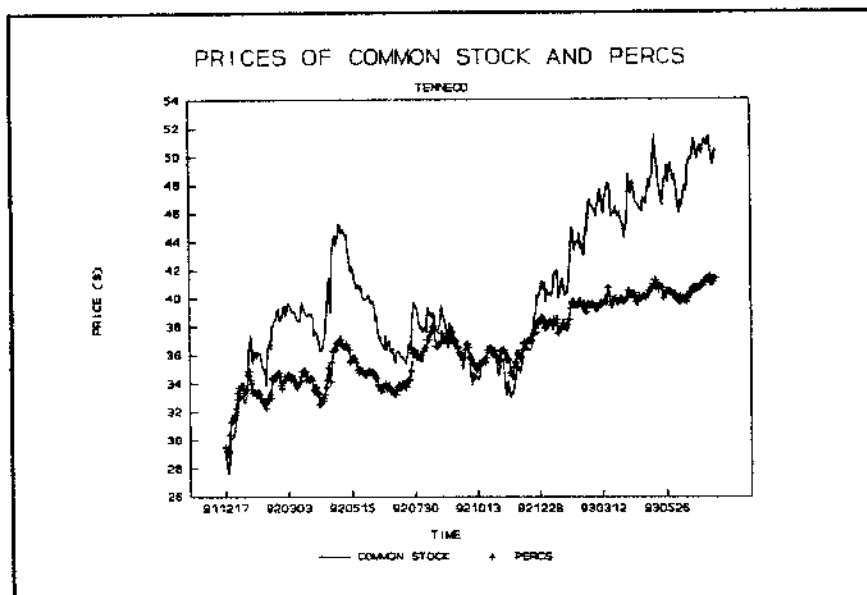


FIGURE 11

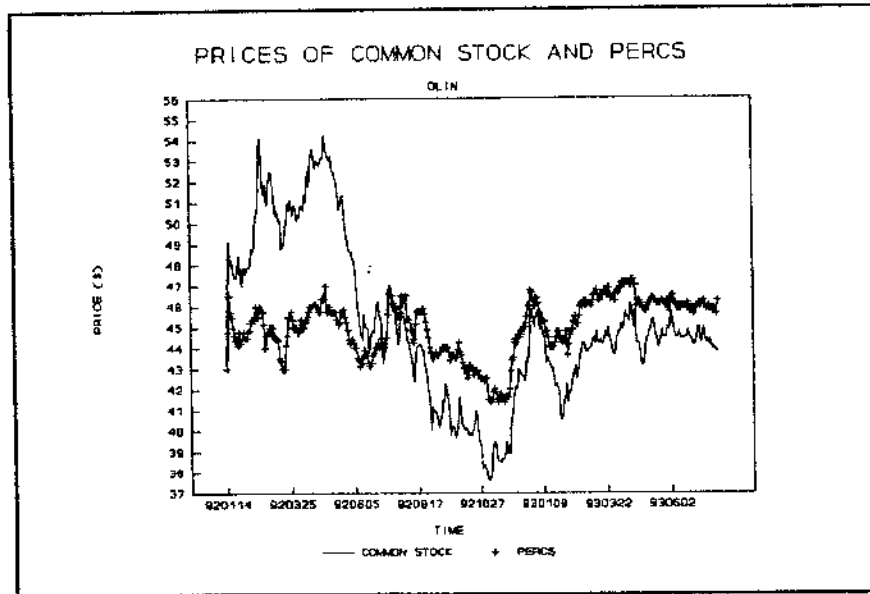


FIGURE 12

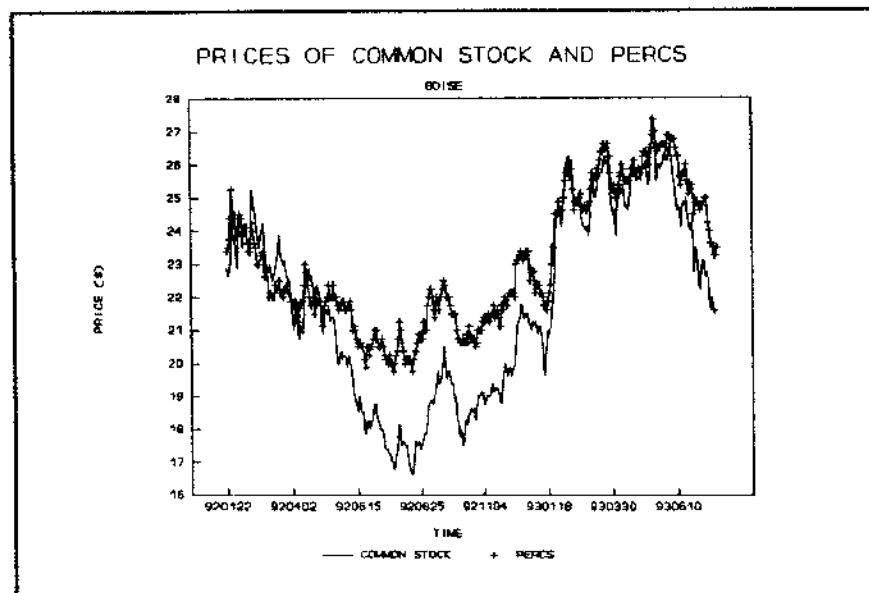


FIGURE 13

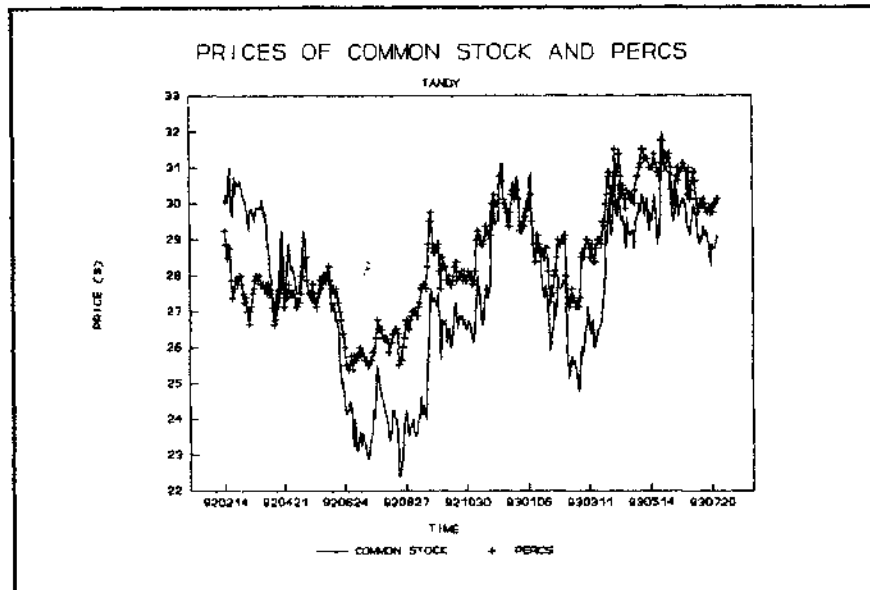


FIGURE 14

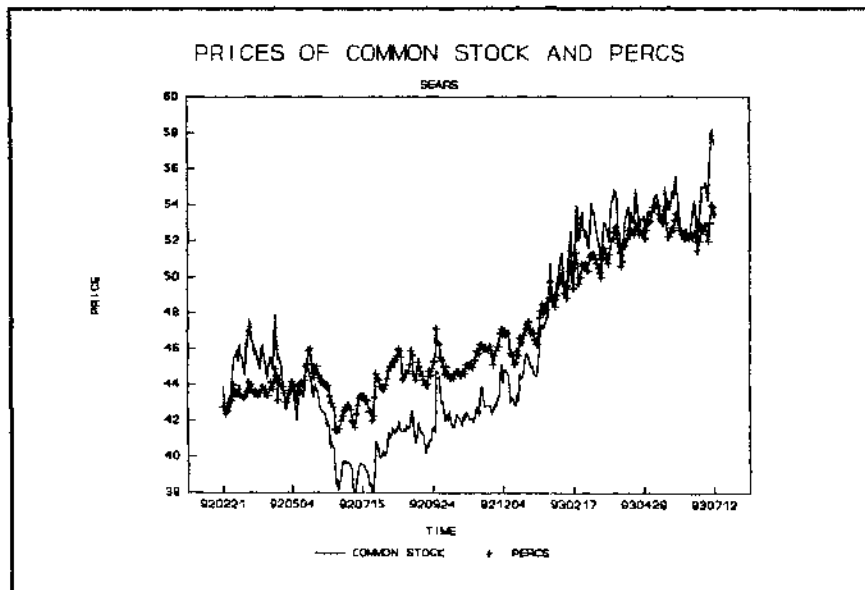


FIGURE 15

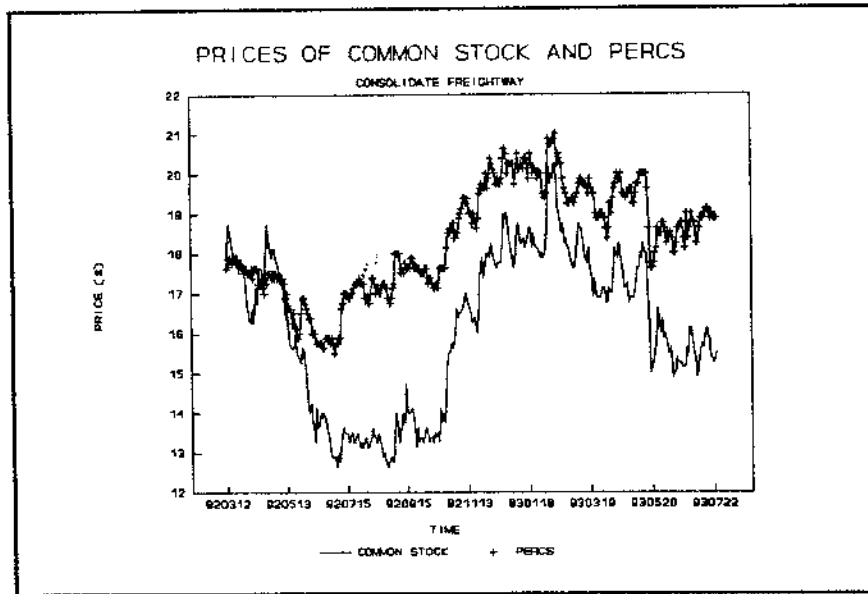


FIGURE 16

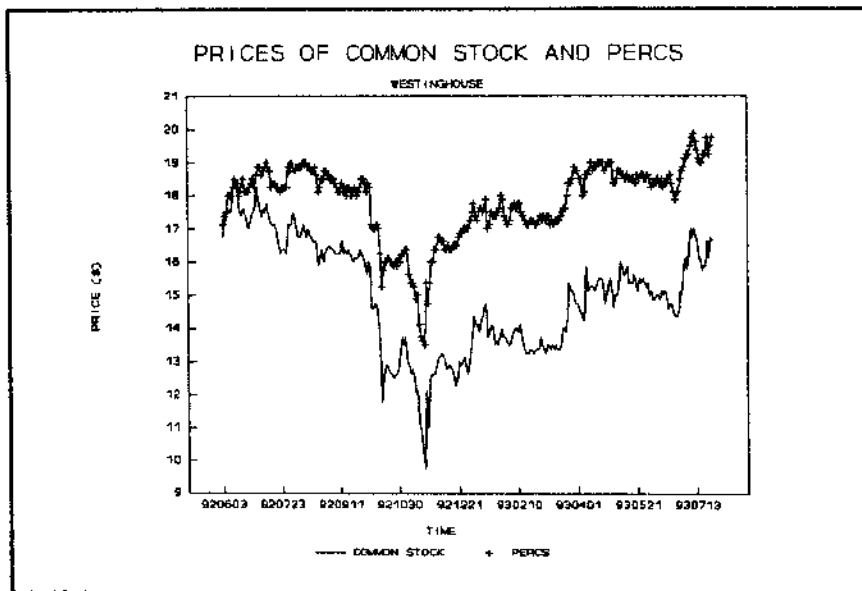


FIGURE 17

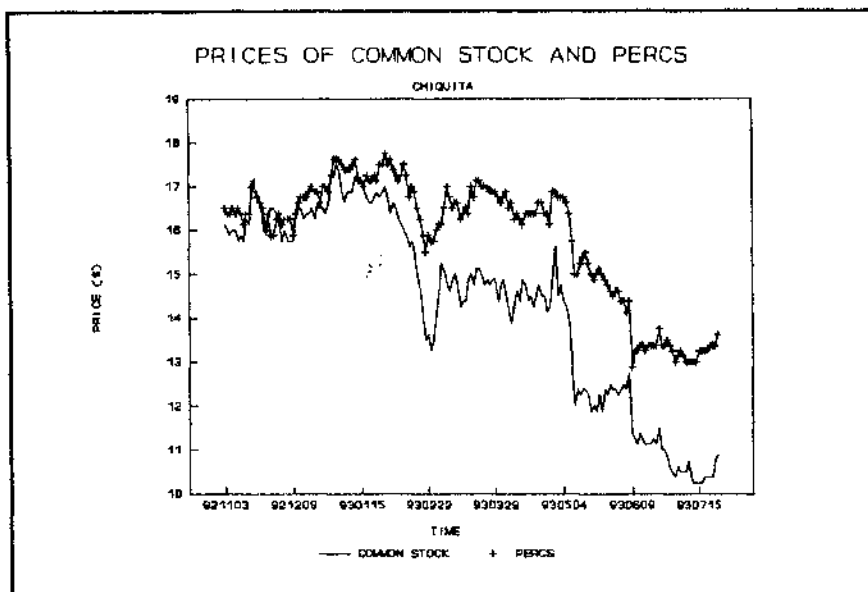
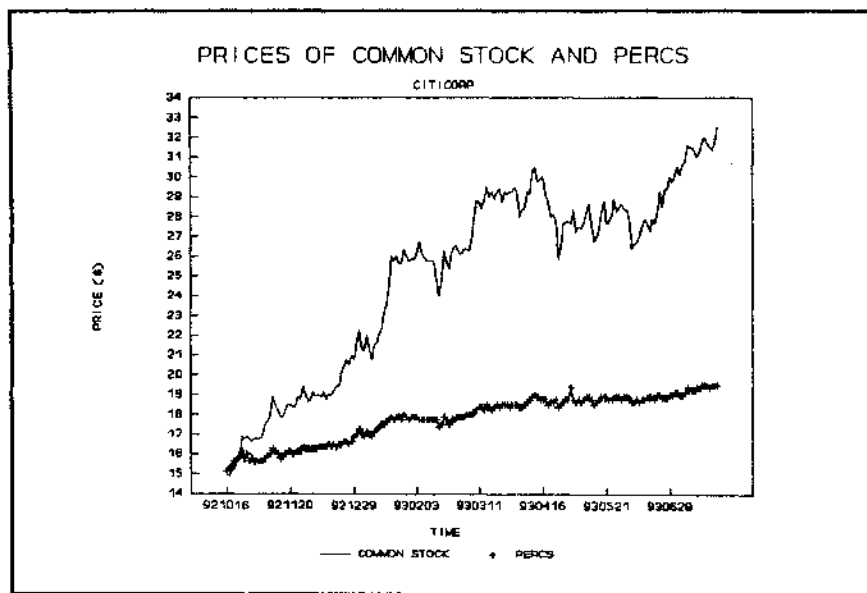


FIGURE 18



APPENDIX II

RESULTS OF TESTS ON THE SYNCHRONISM
BETWEEN COMMON AND PERCS PRICES

TABLE 3
THE RESULTS OF TESTS ON HYPOTHESIS I

$$H_0: E\{\epsilon_{it}\} \leq 0$$

Company	N	Mean	T
Avon	325	0.240	10.63 [^]
General Motors	242	0.371	13.56 [^]
Kmart	215	0.297	10.76 [^]
Texas Instruments	226	0.229	10.95 [^]
RJR Nabisco	123	0.080	6.10 [^]
Broad (SunAmerica)	100	0.099	4.78 [^]
Aon	199	0.158	7.31 [^]
Tenneco	186	0.213	9.24 [^]
Olin	154	0.192	7.13 [^]
Boise	161	0.144	6.66 [^]
Tandy	159	0.222	11.27 [^]
Sears	161	0.338	11.78 [^]
Consolidated Freightway	130	0.098	4.39 [^]
Westinghouse	106	0.164	6.98 [^]
Chiquita	66	0.083	2.93 [^]
Citicorp	103	0.070	5.52 [^]
N: Number of observations. Mean: Mean of ϵ_{it} . T: T-statistics of the test. ^: Significant at 1% level.			

TABLE 4
THE RESULTS OF TESTS ON HYPOTHESIS II

$H_0: E\{\epsilon_{Dt}\} \geq 0$

Company	N	Mean	T
Avon	340	-0.205	- 9.58 [^]
General Motors	237	-0.356	-13.94 [^]
Kmart	230	-0.273	-10.23 [^]
Texas Instruments	219	-0.196	-10.06 [^]
RJR Nabisco	157	-0.096	- 7.63 [^]
Broad (SunAmerica)	115	-0.055	- 2.66 [^]
Aon	189	-0.111	- 5.61 [^]
Tenneco	191	-0.145	- 8.16 [^]
Olin	180	-0.153	- 7.07 [^]
Boise	164	-0.149	- 7.48 [^]
Tandy	167	-0.212	- 9.39 [^]
Sears	164	-0.232	- 9.38 [^]
Consolidated Freightway	156	-0.061	- 3.39 [^]
Westinghouse	125	-0.116	- 5.05 [^]
Chiquita	87	-0.093	- 3.25 [^]
Citicorp	69	-0.049	- 2.53 [^]

N: Number of observations.
Mean: Mean of ϵ_{Dt} .
T: T-statistics of the test.
[^]: Significant at 1% level.

TABLE 5
THE RESULTS OF TESTS ON HYPOTHESIS III

$H_0: E\{\eta_{U_i}\} \geq 0$

Company	N	Mean	T
Avon	325	-0.343	-13.71 [^]
General Motors	242	-0.267	- 9.88 [^]
Kmart	215	-0.417	-14.70 [^]
Texas Instruments	226	-0.695	-14.45 [^]
RJR Nabisco	123	-0.122	- 9.73 [^]
Broad (SunAmerica)	100	-0.366	-10.86 [^]
Aon	199	-0.349	-12.17 [^]
Tenneco	186	-0.420	-11.30 [^]
Olin	154	-0.325	-11.02 [^]
Boise	161	-0.179	- 9.15 [^]
Tandy	159	-0.219	-10.76 [^]
Sears	161	-0.350	-10.12 [^]
Consolidated Freightway	130	-0.224	- 9.71 [^]
Westinghouse	106	-0.170	- 7.72 [^]
Chiquita	66	-0.201	- 6.33 [^]
Citicorp	103	-0.400	-13.22 [^]

N: Number of observations.
 Mean: Mean of η_{U_i} .
 T: T-statistics of the test.
[^]: Significant at 1% level.

TABLE 6
THE RESULTS OF TESTS ON HYPOTHESIS IV

$$H_0: E\{\eta_{Dt}\} \geq 0$$

Company	N	Mean	T
Avon	340	-0.292	-11.98 [^]
General Motors	237	-0.266	-10.96 [^]
Kmart	230	-0.403	-13.51 [^]
Texas Instruments	219	-0.545	-12.65 [^]
RJR Nabisco	157	-0.093	- 8.21 [^]
Broad (SunAmerica)	115	-0.266	-10.47 [^]
Aon	189	-0.333	-12.57 [^]
Tenneco	191	-0.359	-15.73 [^]
Olin	180	-0.286	-10.85 [^]
Boise	164	-0.177	- 8.52 [^]
Tandy	167	-0.213	-10.69 [^]
Sears	164	-0.313	-13.04 [^]
Consolidated Freightway	156	-0.223	-13.14 [^]
Westinghouse	125	-0.168	- 8.82 [^]
Chiquita	87	-0.182	- 7.78 [^]
Citicorp	69	-0.400	- 9.86 [^]

N: Number of observations.
 Mean: Mean of η_{Dt} .
 T: T-statistics of the test.
[^]: Significant at 1% level.

APPENDIX III

PREDICTED VALUE AND MARKET PRICE OF PERCS

FIGURE 19

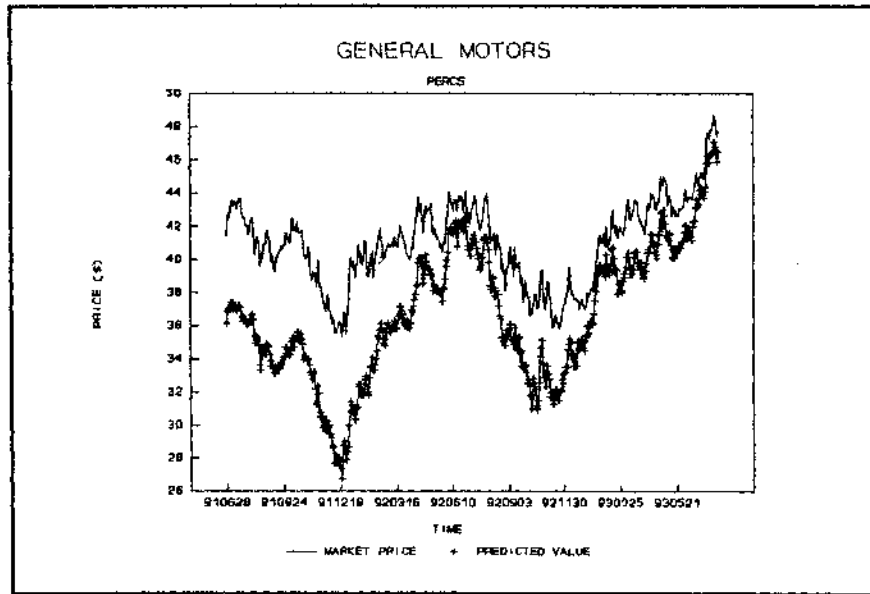


FIGURE 20

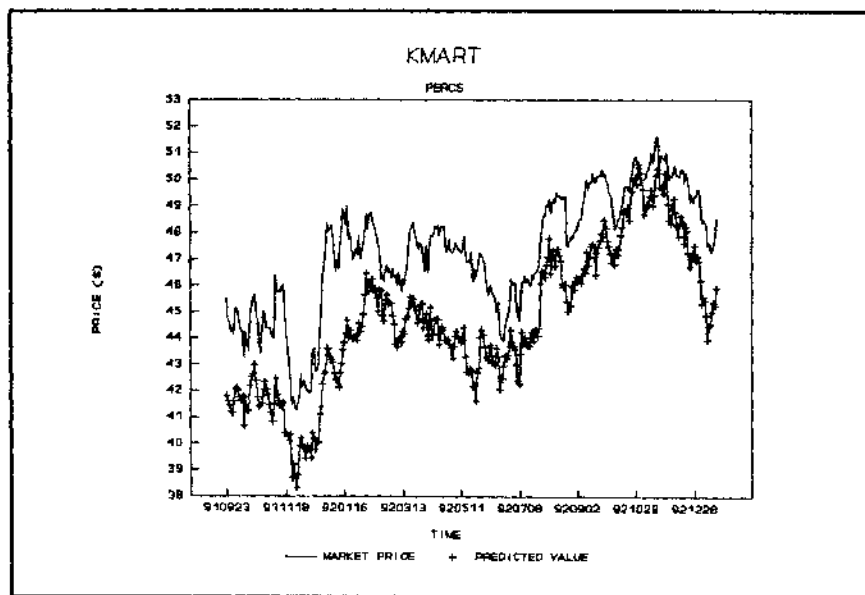


FIGURE 21

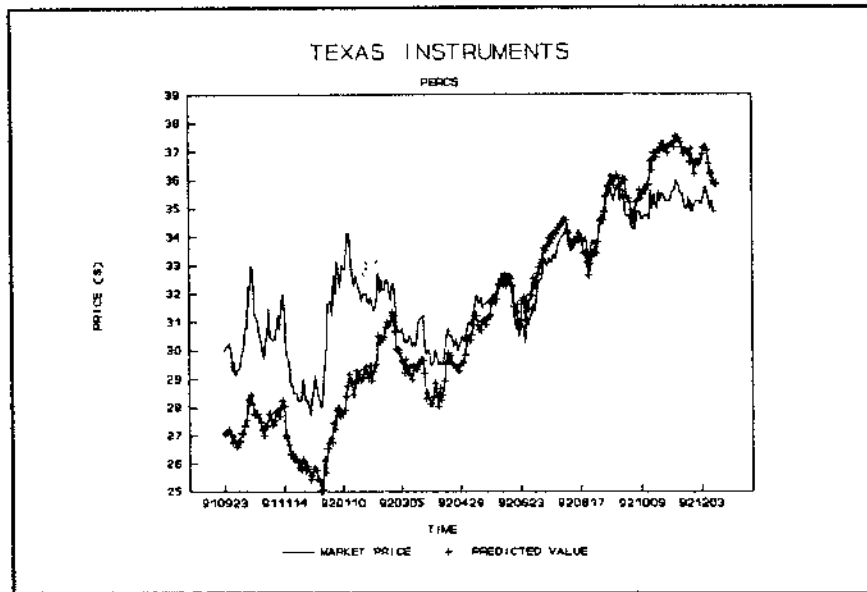


FIGURE 22

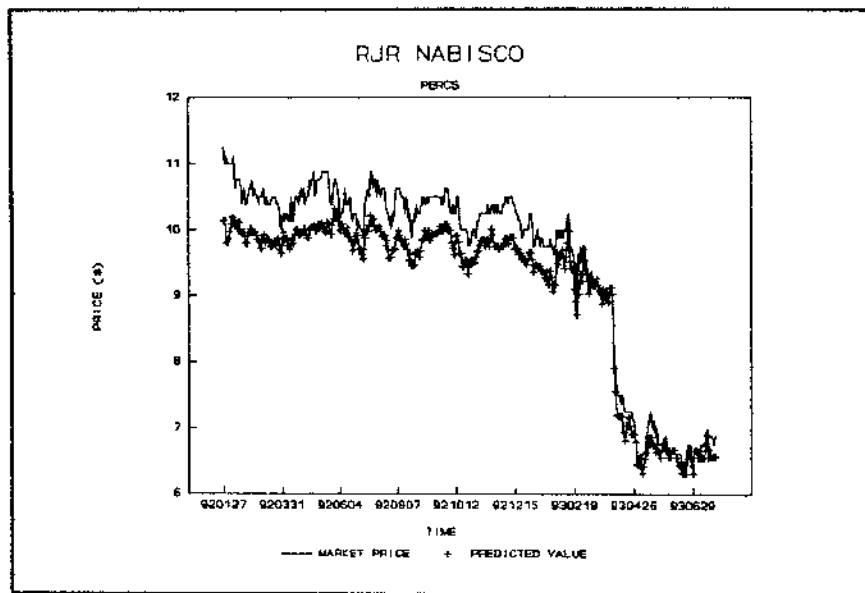


FIGURE 23

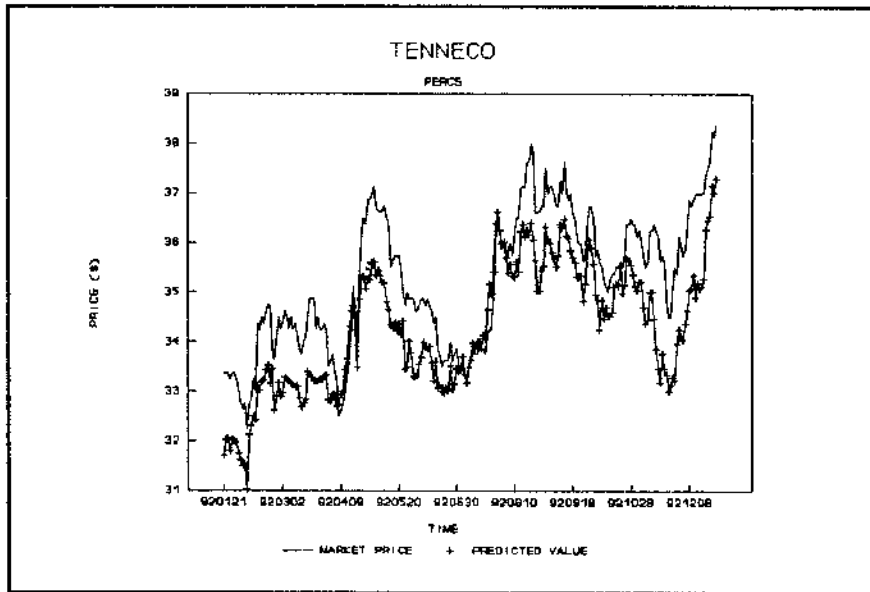


FIGURE 24

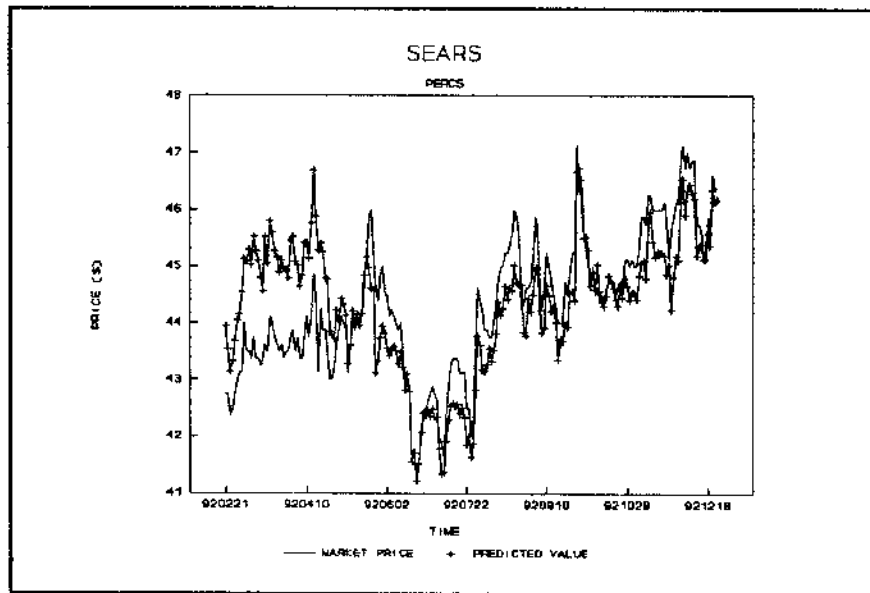


FIGURE 25

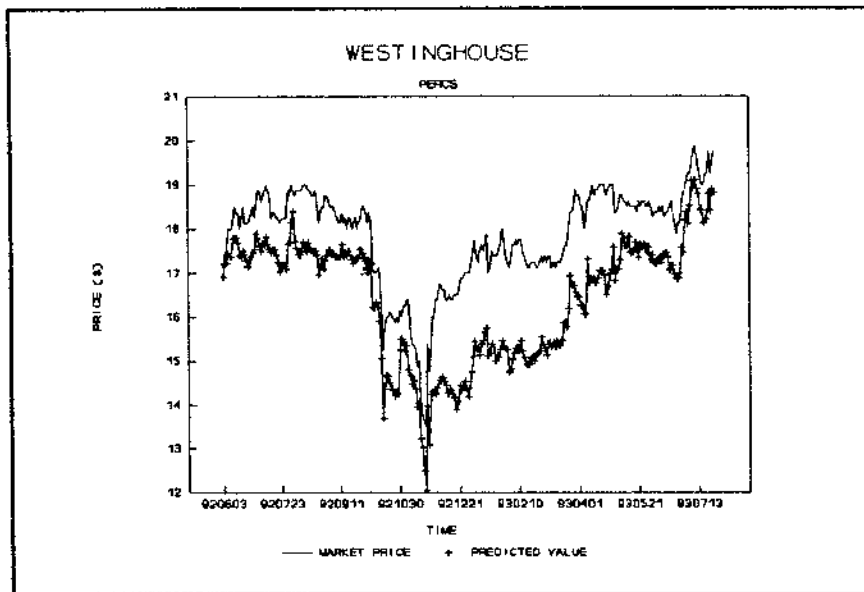
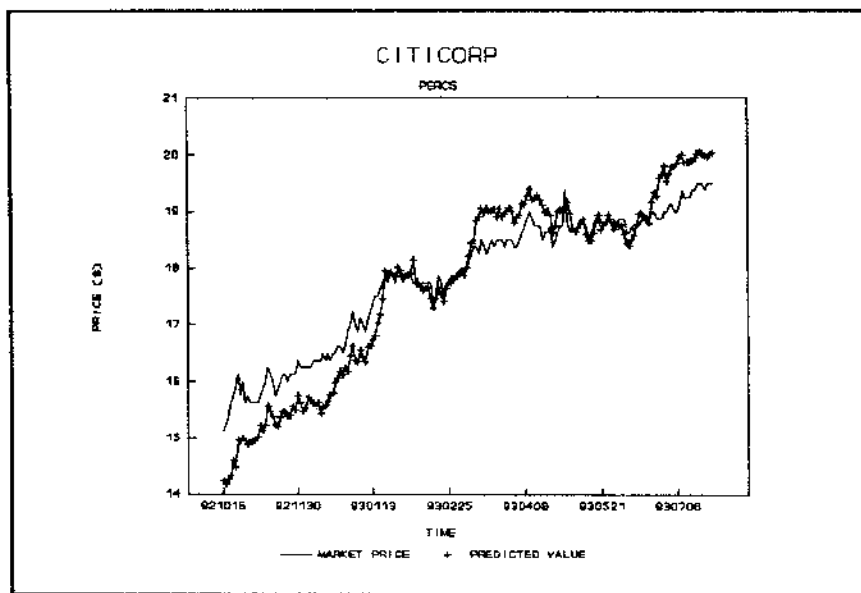


FIGURE 26



APPENDIX IV

RESULTS OF THE TESTS ON
PERCS-COMMON PRICE PARITY

TABLE 9

THE RESULTS OF TEST V

$H_0: E\{\delta\}=0$

Company	N	Mean of δ	T	Mean of δ_i/P_i
General Motors	525	\$4.29	47.12 [^]	10.67%
Kmart	336	\$2.55	46.20 [^]	5.43%
Texas Instruments	315	\$0.95	9.05 [^]	3.18%
RJR Nabisco	379	\$0.43	35.40 [^]	4.34%
Tenneco	237	\$0.52	10.48 [^]	1.39%
Sears	215	\$0.02	0.42	0.03%
Westinghouse	290	\$1.42	40.12 [^]	8.06%
Citicorp	195	\$0.08	2.25 ^{^^}	0.64%

N: Number of observations.
[^] (^{^^}): Significant at 1% (5%) level.

APPENDIX V

VALUE OF THE CALL IN PERCS VS.
PRICE OF THE CLOSEST LEAP

*

FIGURE 27

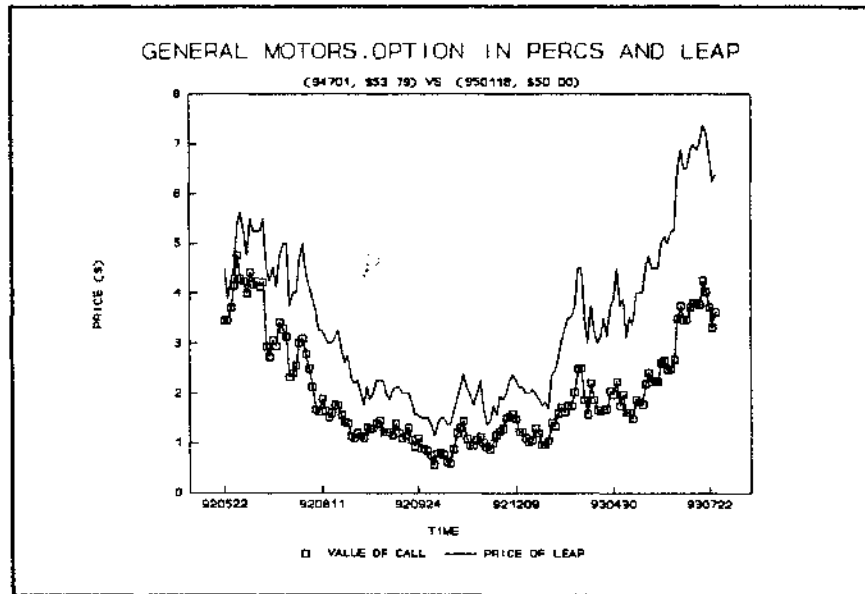


FIGURE 28

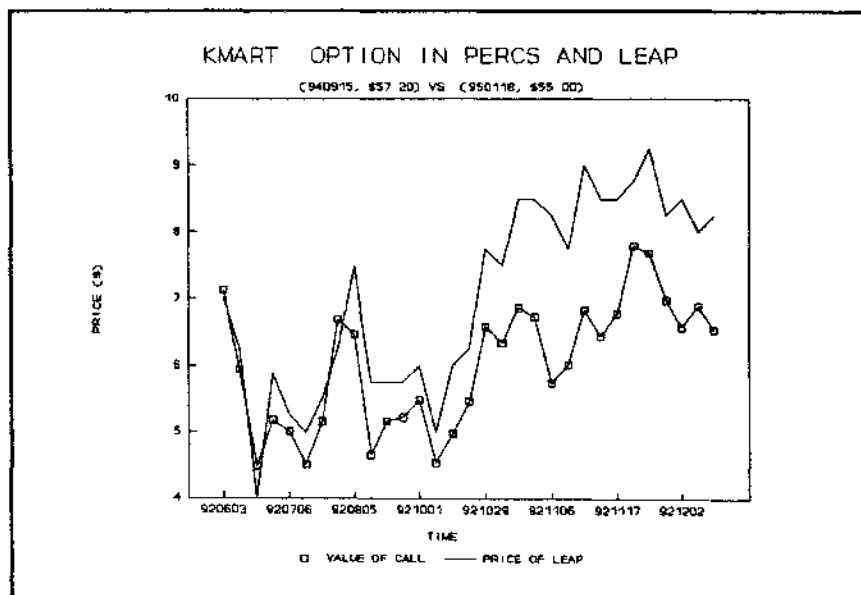


FIGURE 29

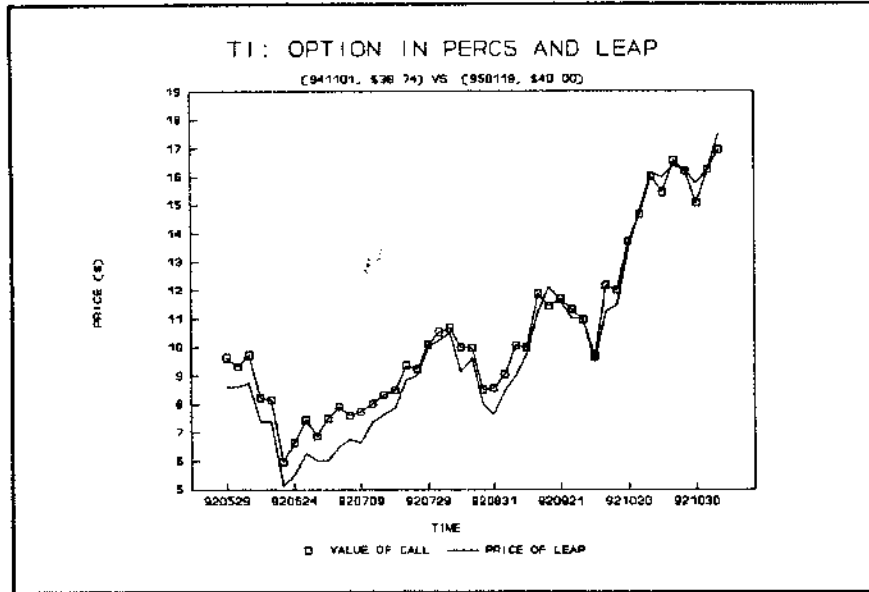


FIGURE 30

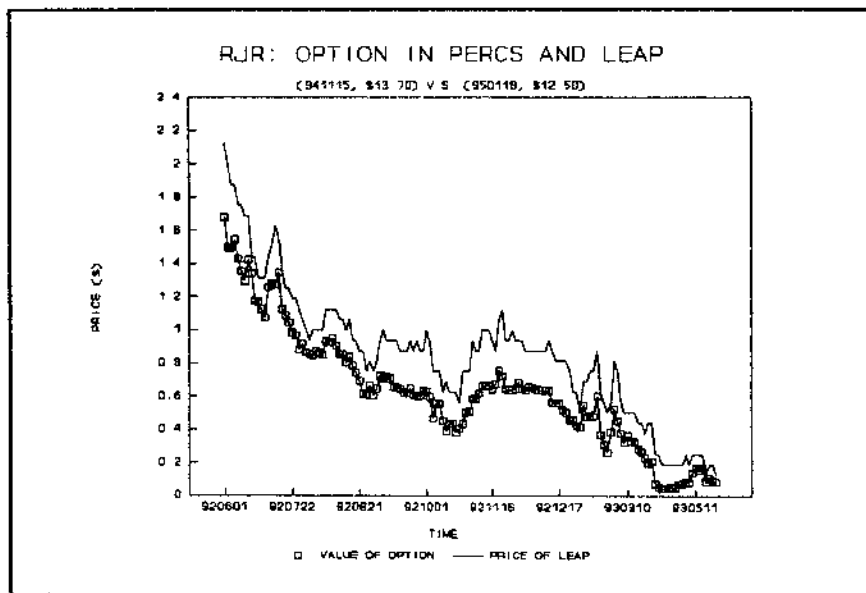


FIGURE 31

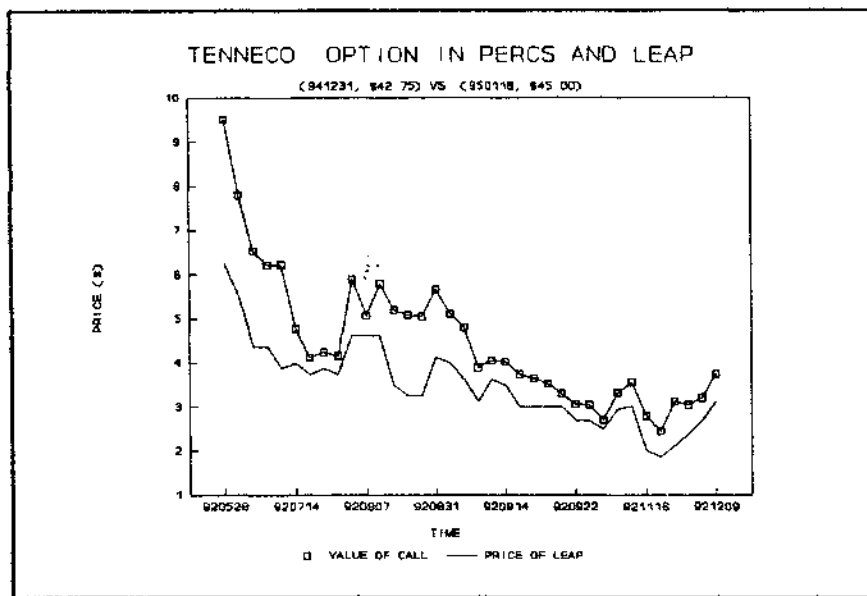


FIGURE 32

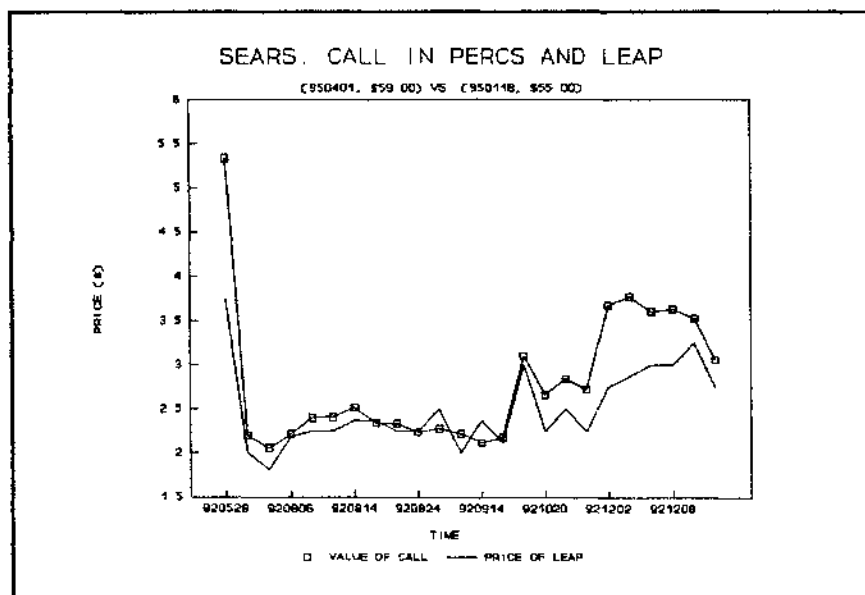


FIGURE 33

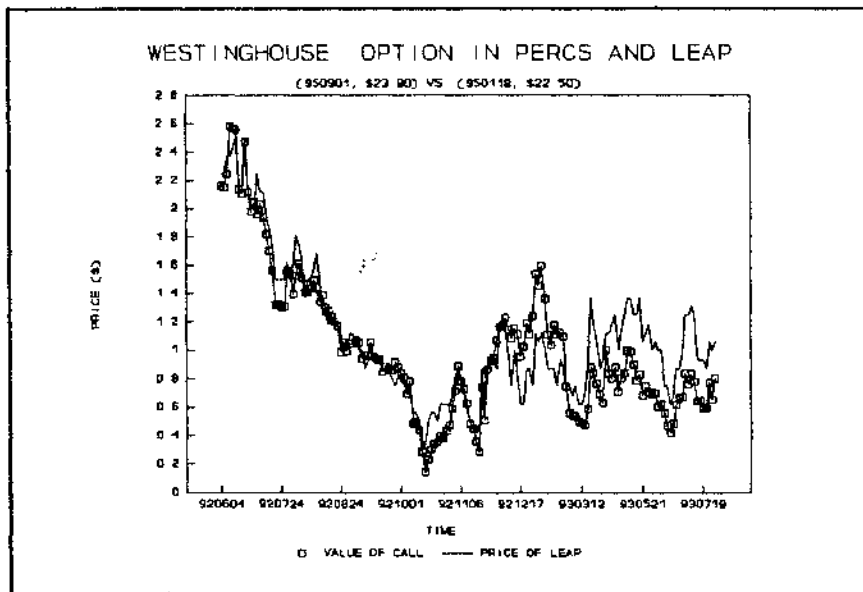
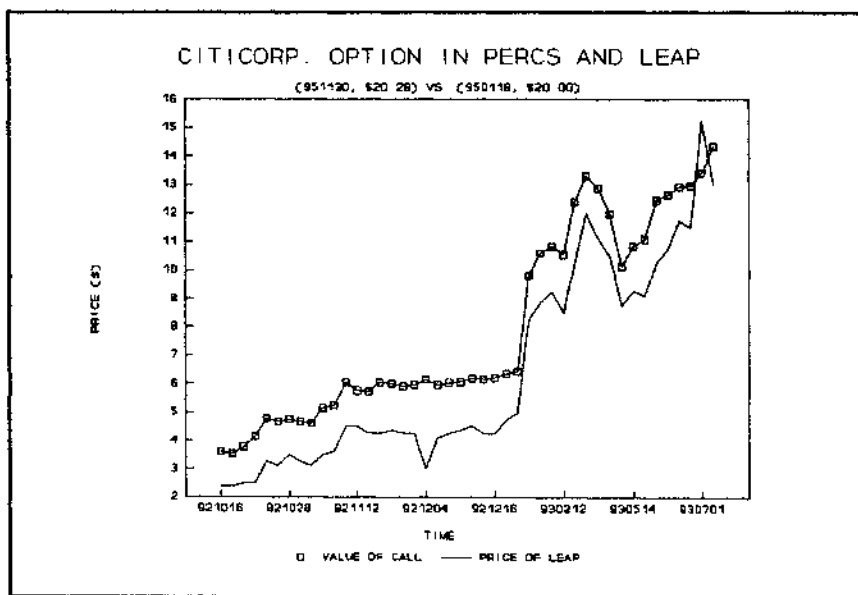


FIGURE 34



APPENDIX VI

RESULTS OF TESTS ON ARBITRAGE RESTRICTIONS

TABLE 13

THE RESULTS OF TESTS ON HYPOTHESIS VII

$H_0: E\{\mu_{it}\} \geq 0$

Company	N	Mean of μ_{it}	T
General Motors	148	-\$0.13	- 0.89
Kmart	32	-\$4.74	-24.63 [^]
Texas Instruments	104	-\$4.97	-37.06 [^]
RJR Nabisco	205	-\$0.59	-40.88 [^]
Tenneco	57	-\$5.10	-33.31 [^]
Sears	24	-\$2.95	-17.58 [^]
Westinghouse	11	-\$0.35	- 3.17 [^]
Citicorp	45	-\$3.65	-18.27 [^]
N: Number of observations ^: Significant at 1% level.			

APPENDIX VII

RESULTS OF EVENT STUDIES ON THE ISSUE OF PERCS

TABLE 16
 AVERAGE ABNORMAL RETURNS AROUND THE
 ANNOUNCEMENT DAY OF PERCS OFFERING

Day/Period	Average AR/CAR	Z
-5	0.0035	0.45
-4	0.0016	0.32
-3	-0.0077	-1.02
-2	-0.0056	-0.91
-1	-0.0118	-2.03 ^^
0	0.0066	1.10
+1	-0.0084	-1.40
+2	0.0017	0.18
+3	-0.0021	-0.46
+4	-0.0068	-1.09
+5	0.0043	0.82
-1 to 0	-0.0052	-0.66
-2 to -1	-0.0175	-2.07 ^^
-3 to -1	-0.0251	-2.27 ^^

^^: significant at 5% level.

TABLE 17
 AVERAGE ABNORMAL RETURNS
 AROUND PERCS ISSUE DAY

Day/Period	Average AR/CAR	Z
-5	-0.0038	-0.63
-4	-0.0020	-0.03
-3	-0.0070	-1.68
-2	0.0009	-0.07
-1	-0.0168	-2.50 ^
0	-0.0025	-0.34
+1	0.0081	1.00
+2	0.0029	0.24
+3	0.0095	1.26
+4	0.0050	0.98
+5	0.0117	1.68
-1 to 0	-0.0193	-2.01 ^^
^ (^): significant at 1% (5%) level.		

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