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## **Faculty Working Papers**

**DIFFERENTIAL CHANGES IN EXTERNAL MARKET  
LIQUIDITY**

**Frank K. Reilly and James A. Gentry**

**#426**

**College of Commerce and Business Administration  
University of Illinois at Urbana-Champaign**



FACULTY WORKING PAPERS

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DIFFERENTIAL CHANGES IN EXTERNAL MARKET  
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#426





## ABSTRACT

### DIFFERENTIAL CHANGES IN EXTERNAL MARKET LIQUIDITY

External market liquidity refers to the ability to buy or sell an asset quickly with little price change. Using a market liquidity measure developed by Amivest Corporation, there is an analysis of aggregate market liquidity during the period 1969-1975. Subsequently, using two samples of 24 larger firms and 24 smaller firms, there is a comparison of the levels of liquidity and a comparison of changes in liquidity for the two samples during this period.

CHAPTER 1

THE HISTORY OF THE UNITED STATES

1776-1865

The history of the United States is a story of growth and change. From the first European settlers to the present day, the nation has expanded its territory and diversified its population. The American Revolution of 1776 marked the beginning of a new era of self-governance. The Civil War of 1861-1865 was a pivotal moment in the nation's history, leading to the abolition of slavery and the strengthening of the federal government. The Reconstruction period that followed was a time of struggle and progress, as the nation sought to rebuild and reunite. The Gilded Age and Progressive Era saw the rise of industrialization and the emergence of new social and political movements. The 20th century was a period of global conflict, social change, and technological advancement. The Vietnam War and the Civil Rights Movement were defining moments of the era. The end of the 20th century saw the fall of the Soviet Union and the beginning of a new world order. The 21st century has been a time of rapid technological change and global interconnectedness. The United States continues to play a leading role in the world, facing new challenges and opportunities.

## DIFFERENTIAL CHANGES IN EXTERNAL

### MARKET LIQUIDITY\*

Frank K. Reilly  
James A. Gentry\*\*

### INTRODUCTION

External market liquidity refers to the ability to buy or sell an asset quickly with little price change assuming no new information. This characteristic is important to all investors because the lack of it can increase the cost of an asset to the purchaser or decrease the revenue to the seller of an asset. This attribute has become important to portfolio managers of large institutions concerned with the ability to buy or sell blocks of stock [4, 6, 7]. Because institutional investors are the dominant force in the secondary market, market liquidity becomes important for the financial manager considering new external equity capital. If a company's stock does not enjoy a liquid secondary market, it is unlikely the company can sell a new primary issue. In addition, a poor secondary market can add to the risk of the stock and increase the firm's required rate of return on equity.

The purpose of this paper is threefold. The first is to discuss a measure of external market liquidity that can be used to examine changes in liquidity for the aggregate stock market and for individual stocks. The second purpose is to examine this liquidity measure for the aggregate market

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\*The authors acknowledge the assistance of Milan Saric and Paul Skelton.

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THE UNIVERSITY OF CHICAGO

PHYSICS DEPARTMENT

PHYSICS 311

LECTURE 10

THEORY OF THE QUANTUM MECHANICAL TUNNELING EFFECT

1. INTRODUCTION. In the previous lecture we have seen that the wave function of a particle of mass  $m$  and energy  $E$  is given by

$$\psi(x) = A e^{ikx} + B e^{-ikx} \quad (1)$$

in the region where the potential energy is zero. In the region where the potential energy is  $V_0$ , the wave function is given by

$$\psi(x) = C e^{-\kappa x} + D e^{\kappa x} \quad (2)$$

where  $\kappa = \sqrt{2m(V_0 - E)}$ . The wave function must be continuous at the boundary  $x = 0$ , and its derivative must also be continuous.

Applying these conditions to the wave function in the two regions, we find that

$$A + B = C + D \quad (3)$$

$$ik(A - B) = -\kappa(C - D) \quad (4)$$

These two equations can be solved for  $C$  and  $D$  in terms of  $A$  and  $B$ . The result is

$$C = \frac{1}{2} \left( 1 + \frac{\kappa}{ik} \right) (A + B) \quad (5)$$

$$D = \frac{1}{2} \left( 1 - \frac{\kappa}{ik} \right) (A + B) \quad (6)$$

It is clear that the wave function is not zero in the region  $x > 0$ , even though the energy  $E$  is less than the potential energy  $V_0$ .

The probability of finding the particle in the region  $x > 0$  is given by the integral of the square of the wave function over that region.

$$P = \int_0^{\infty} |\psi(x)|^2 dx = \int_0^{\infty} |C e^{-\kappa x} + D e^{\kappa x}|^2 dx \quad (7)$$

Since the wave function must be finite at  $x = \infty$ , we must have  $D = 0$ . This means that the wave function is given by

$$\psi(x) = C e^{-\kappa x} \quad (8)$$

and the probability of finding the particle in the region  $x > 0$  is given by

$$P = \frac{|C|^2}{2\kappa} \quad (9)$$

over time and demonstrate how external market liquidity has varied. Finally, there is an analysis of market liquidity for two samples of individual firms. The samples include 24 larger firms from the top of the Fortune 1000 list and a sample of 24 smaller firms from the bottom of the Fortune 1000 list. The liquidity measure for the two different samples is examined over time in order to provide answers to two questions of concern to portfolio managers and corporate financial managers. First, is there a significant difference in the average level of market liquidity for large and small firms? The general consensus is that larger firms enjoy a higher level of market liquidity. If so, it should be of interest to know how much higher. The second question is concerned with changes in the level of market liquidity for the two samples during the period 1969-1975. Some observers have speculated that since 1969 there has been a differential change in market liquidity for large versus small firms because of the emergence of a tiered market.

## AGGREGATE STOCK MARKET LIQUIDITY

### A Liquidity Measure

As noted, market liquidity is the ability to buy or sell an asset quickly with little price change. Given this definition, the important attributes that require measurement are the *time* involved in a trade and the *price change*. Generally, information regarding the time required to complete a trade is not available. Fortunately, the time variable is probably not a crucial requirement because most trades not involving large "blocks" of stock (10,000 shares or more) are completed rapidly--in less than an hour, and in most instances in less than 15 minutes. Therefore, the time dimension is relatively constant. Hence the *price change* becomes

1. The first part of the document discusses the importance of maintaining accurate records of all transactions. It emphasizes that proper record-keeping is essential for the success of any business and for the protection of the interests of all parties involved. This section also outlines the various methods and systems that can be used to ensure the accuracy and reliability of the records.

2. The second part of the document focuses on the role of the auditor in verifying the accuracy of the financial statements. It describes the various procedures and techniques that auditors use to identify and prevent errors and fraud. This section also discusses the importance of the auditor's independence and the need for a high level of professional skepticism.

3. The third part of the document discusses the various factors that can affect the reliability of the financial statements. It includes a discussion of the various accounting methods and principles that can be used to measure and report financial performance. This section also discusses the importance of the auditor's judgment and the need for a high level of professional judgment.

4. The fourth part of the document discusses the various risks that are associated with the use of financial statements. It includes a discussion of the various risks that are associated with the use of financial statements, such as the risk of misstatement, the risk of fraud, and the risk of non-compliance. This section also discusses the importance of the auditor's role in identifying and managing these risks.

5. The fifth part of the document discusses the various ways in which the financial statements can be used to make decisions. It includes a discussion of the various ways in which the financial statements can be used to make decisions, such as the use of financial ratios, the use of trend analysis, and the use of comparative analysis. This section also discusses the importance of the auditor's role in providing the necessary information for these decisions.

### CONCLUSION

In conclusion, the financial statements are a key part of any business's financial reporting. They provide a clear and concise summary of the company's financial performance and position. The auditor's role is to verify the accuracy of these statements and to provide an independent opinion on their reliability. This is a crucial part of the business's financial reporting process and is essential for the success of the business and for the protection of the interests of all parties involved.

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the variable of importance, but it is not simply price change. Not all trades are of equal size in terms of the number of shares involved and/or the value of the trade. Clearly one should relate the price change to the amount of trading. Such a measure has been developed by the Amivest Corporation, a New York research firm. The specific measure is derived daily for all stocks on the NYSE and the ASE and an unweighted average for all stocks is computed. The average of the daily values for a month is used as the monthly figure. The computation for each stock is as follows [2]:

$$\text{Amivest \$ Index} = \frac{\text{Dollar Volume of Trading}}{\text{Percent Price Change Without Sign}}$$

This measure indicates the value of trading for every 1 percent price change. The larger the value of the index, the more trading that is possible without a major price change. Such a series for the aggregate market was not available prior to 1973 so it was necessary to derive a proxy. Such a proxy series was developed as part of another study for the period 1964-1975 [9]. The proxy series was computed monthly as:

$$\text{Amivest \$ Index} = \frac{\text{Dollar Value of Trading on the NYSE}}{\text{Sum of Daily Percent Price Changes w/o Sign}}$$

In addition, because some portfolio managers might conceive of liquidity in terms of how many *shares* can be traded, a share index was computed that indicates the number of shares traded per 1 percent change in price. It was computed as follows:

$$\text{Amivest Share Index} = \frac{\text{Total Reported Shares Traded on NYSE}}{\text{Sum of Daily Percent Price Changes w/o Sign}}$$

and variable of importance, but it is not simply price change. Not all trades are equal since in terms of the number of shares involved and/or the value of the trade. Clearly, one should weight the price change to the amount of trading. Such a measure has been developed by the Analyst Corporation, a New York research firm. The significance measure is derived daily for all stocks on the NYSE and the NYSE and is used as the weighty figure.

The correlation for each stock is as follows [1]:

$$\text{Analyst Weighted Index} = \frac{\text{Total Volume of Trading} \times \text{Price Change}}{\text{Total Volume of Trading}}$$

This measure indicates the value of each stock for every 1 percent price change. The larger the value of the index, the more trading that is possible without a major price change. Such a measure for the aggregate market was not available prior to 1972 and it was necessary to use a proxy. Such a proxy series was developed as part of market studies for the period 1964-1972 [2]. The proxy series was based on the following:

$$\text{Analyst Index} = \frac{\text{Total Volume of Trading on the NYSE} \times \text{Price Change}}{\text{Total Volume of Trading}}$$

In addition, the number of trades per day was used as a proxy for liquidity. A series of box plots were drawn for each day of the week to compare that index to the number of trades per day. A 1 percent change in index. It was compared as follows:

$$\text{Analyst Index} = \frac{\text{Total Volume of Trading on the NYSE} \times \text{Price Change}}{\text{Total Volume of Trading}}$$



These measures can also be used to measure the liquidity for individual securities over time. In fact, this is the major use made of the liquidity measure by the originators [2]. In a subsequent section these liquidity measures are used to examine the level of liquidity and changes in liquidity for a sample of larger firms and a sample of smaller firms.

### Aggregate Liquidity Over Time

Exhibits 1 and 2 contain a monthly time series plot of the two Amivest liquidity measures for the period January, 1969-December, 1975. Exhibit 1 contains the dollar index and indicates *significant variation over time* from a low of .19 (\$190,000) during the latter half of 1974, to a high of almost 2.5 (\$2,500,000) during the first half of 1972. Not only is there a wide range of values, but there was substantial variability over time on a month-to-month basis. The point is, the plot indicates that *external market liquidity for the total stock market is clearly not constant over time*. Based upon a casual analysis it appears that a major factor influencing market liquidity is the general market environment. Specifically, liquidity was low during the 1969-70 bear market and also declined steadily during 1973-74 when stock prices fell by over 40 percent. In fact, the series hit its trough during 1974. In contrast, market liquidity reached its high point during the bull market of 1972, and increased from its low point during the rising market of 1975.

The results for the Amivest Share Index (Exhibit 2) are quite similar. In this case the range was from about .08 (80,000 shares) in 1970 and 1974, to a high of over .60 (600,000 shares) during 1972. This similarity in wide ranges is not surprising since the monthly values for the two liquidity

Individuality in liquidity measurement can also be used to assess the liquidity of individual securities over time. In fact, this is the main reason of the liquidity measure by the authors (1991). The subsequent section discusses these individuality measures and ways to examine the level of liquidity of issues in liquidity for a variety of factors such as a firm's market status.

### Programme Liquidity Index

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The authors (1991) used to estimate the liquidity of the two individuality measures for the period 1970-1990. The first measure is the bid-ask spread and the second is the turnover ratio. The bid-ask spread is defined as the difference between the highest price that a buyer is willing to pay and the lowest price that a seller is willing to accept. The turnover ratio is defined as the ratio of the number of shares traded to the number of shares outstanding. The authors (1991) found that the bid-ask spread is higher for issues with lower individuality and the turnover ratio is higher for issues with higher individuality. This finding is consistent with the theory of market microstructure, which suggests that issues with higher individuality are more liquid and have lower bid-ask spreads. The authors (1991) also found that the bid-ask spread is higher for issues with lower turnover ratios, which is also consistent with the theory of market microstructure. The authors (1991) conclude that individuality is an important determinant of liquidity, and that issues with higher individuality are more liquid and have lower bid-ask spreads.

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EXHIBIT 1

TIME SERIES PLOT OF MONTHLY AMIVEST DOLLAR LIQUIDITY  
INDEX FOR NEW YORK STOCK EXCHANGE

January, 1969 - December, 1975

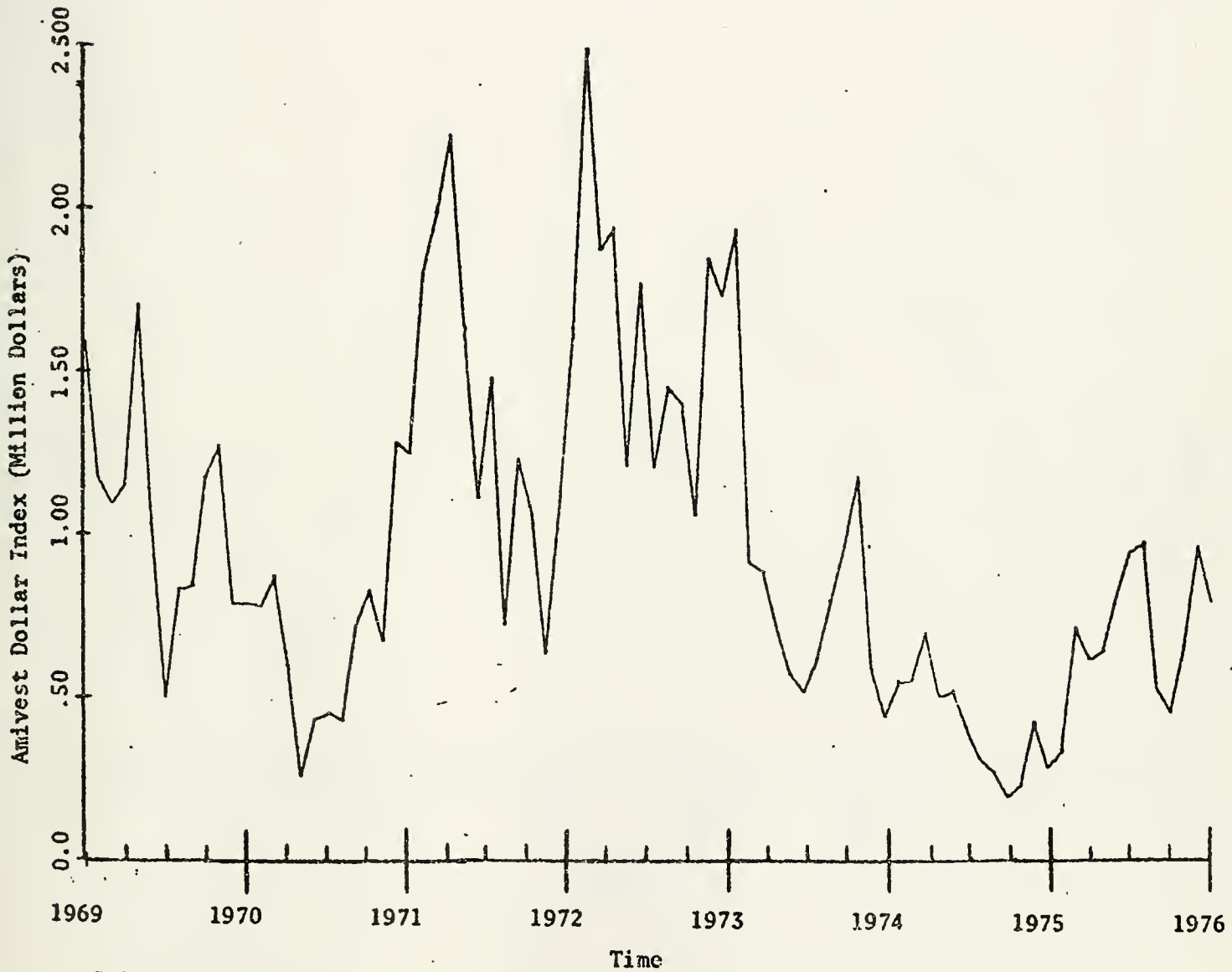


Figure 1

Figure 1 shows the monthly variation of the monthly mean temperature (T<sub>m</sub>) and monthly mean precipitation (P<sub>m</sub>) at the station during the period 1950-1999. The monthly mean temperature (T<sub>m</sub>) is shown in degrees Celsius (°C) and the monthly mean precipitation (P<sub>m</sub>) is shown in millimeters (mm).

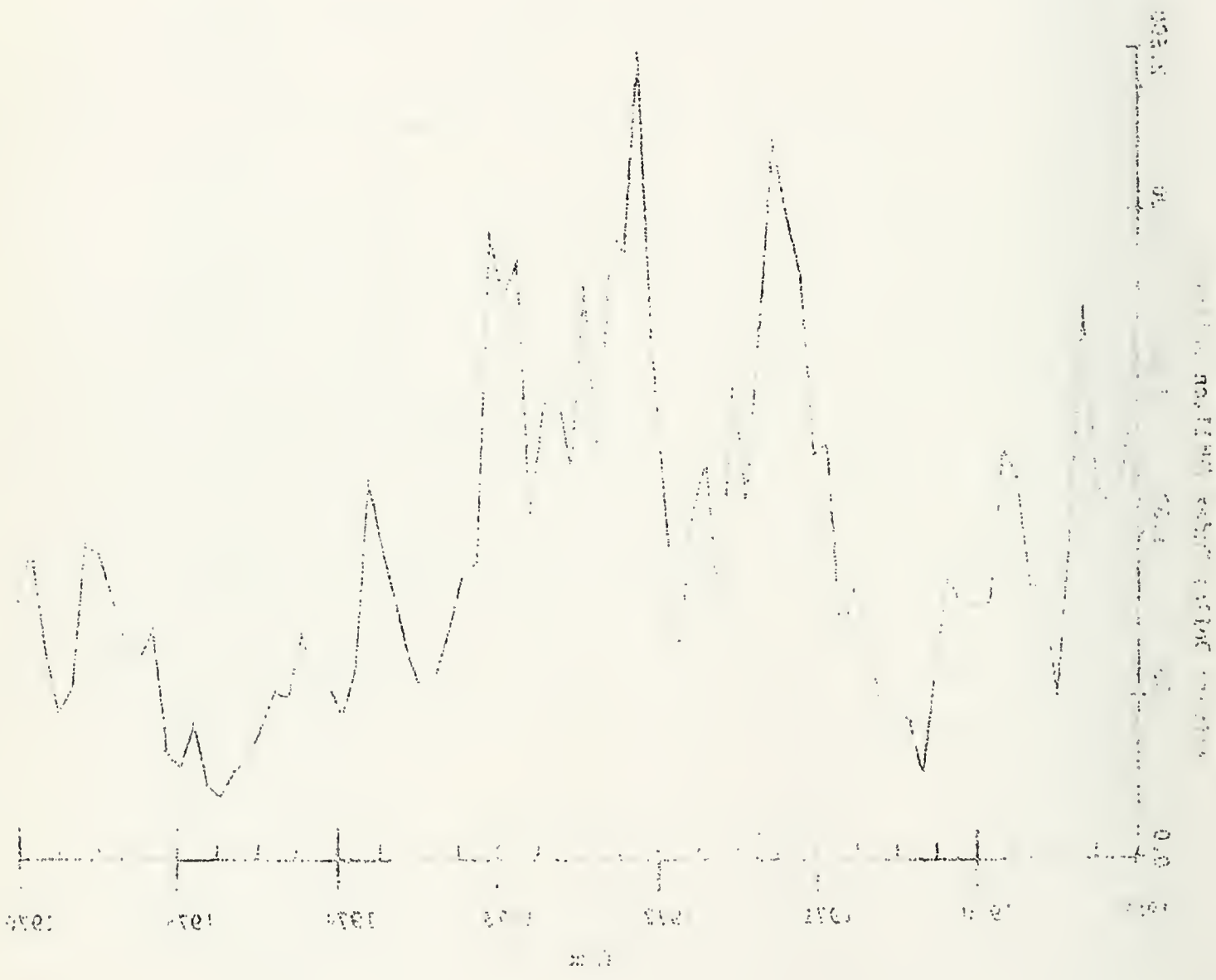


EXHIBIT 2

TIME SERIES PLOT OF MONTHLY AMIVEST SHARE LIQUIDITY  
INDEX FOR THE NEW YORK STOCK EXCHANGE

January, 1969 - December, 1975

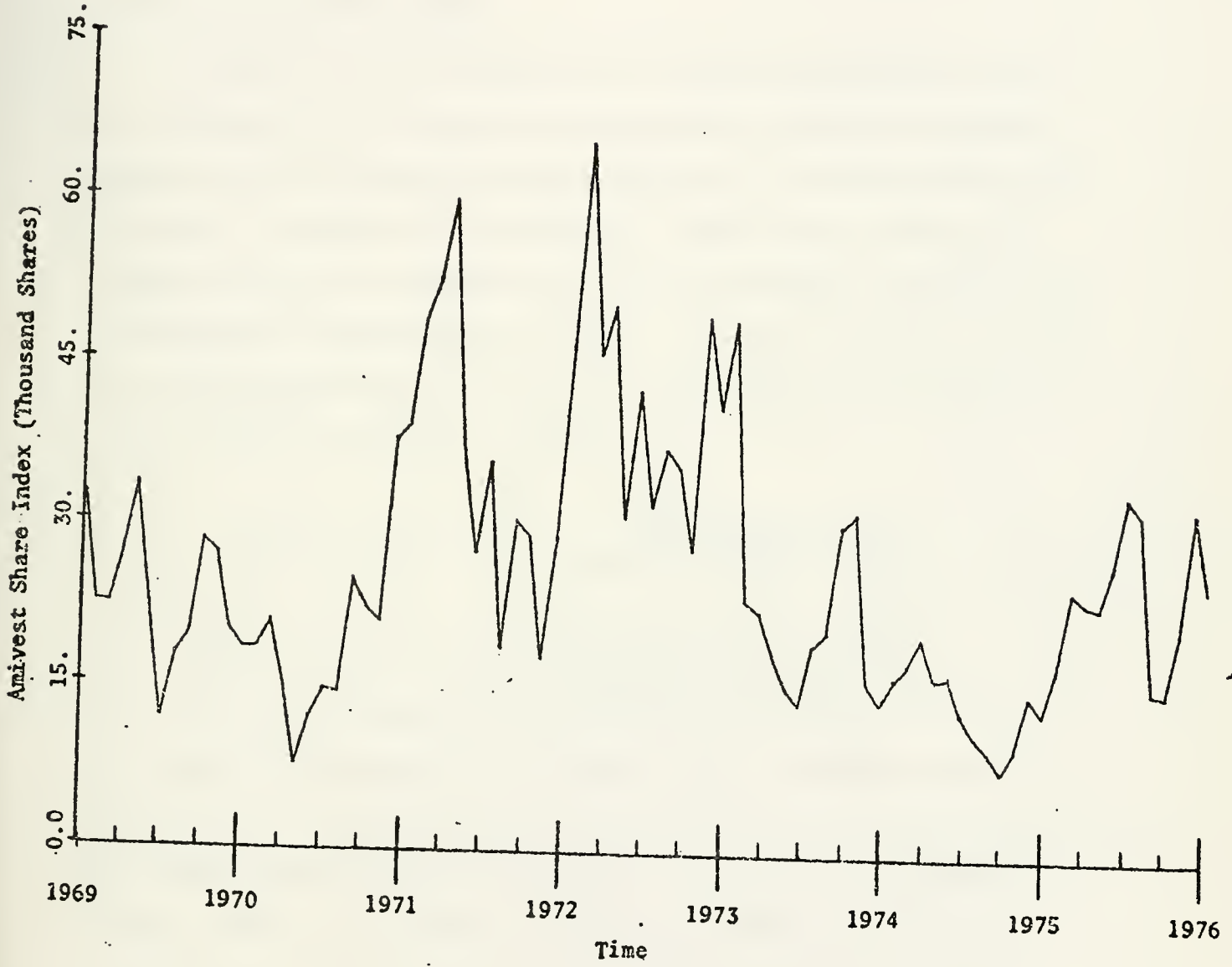
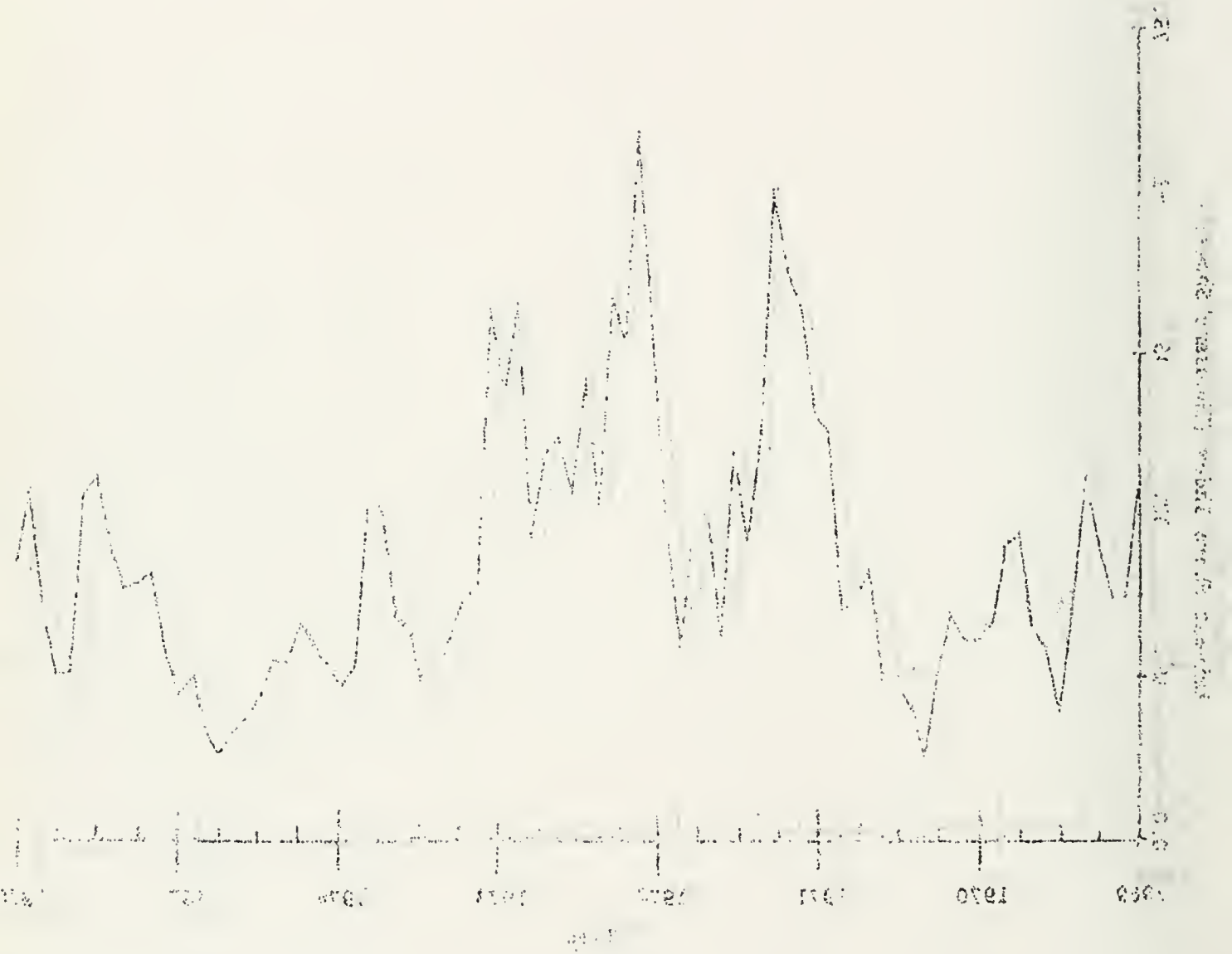


FIGURE 1

MONTHLY VARIATIONS IN THE LEVEL OF THE SEA AT THE STATION

FOR THE YEAR 1961 - 1962

January 1961 - December 1961



series are correlated about .90.

In summary, these graphs indicate that aggregate market liquidity *varies widely over time and is quite volatile on a month-to-month basis.*

### INDIVIDUAL STOCK LIQUIDITY

#### Measures for Individual Stocks

As noted, the Amivest measures can be derived for individual stocks for a period of time. Obviously the computations are much more extensive because total dollar trading and share trading is not available for individual stocks. Therefore it is necessary to determine daily percent price changes for each stock relative to the volume of trading for each day. The share volume is straightforward; the dollar volume was computed as the number of shares traded times the mean of the high and low price for the day. A monthly figure is computed as follows:

$$\text{Amivest Share Index} = \sum_{i=1}^N \frac{\text{Shares Traded Day } i}{\text{Percent Price Change w/o Sign}} \quad N$$

$$\text{Amivest Dollar Index} = \sum_{i=1}^N \frac{\text{Shares Traded} \times (\text{Hi} + \text{Lo} / 2)}{\text{Percent Price Change w/o Sign}} \quad N$$

where N = the number of trading days in the month.

Because of the extensive computations required for each stock, it is not feasible to derive the index for each stock for every month during the time period. Because we wanted to analyze these series for individual stocks over time, it was decided to compute the measure for a specified month each year. Specifically, it was decided to compute the measure during the month of May for each year 1969-1975. The choice of May was

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TABLE I

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arbitrary on the basis that stock prices should not be affected by year-end factors that occur during November to February or influenced by the "summer" rally factors.

An analysis of the liquidity indexes indicated that the liquidity values vary substantially among stocks, and also vary for individual stocks over time. One obvious reason for expecting the liquidity values for individual stocks to vary over time is that the aggregate market liquidity varies substantially. Therefore, it was decided to "normalize" the monthly liquidity value for individual stocks by the aggregate market value for that month. The result is a *relative* measure of liquidity over time as follows:

$$\text{Relative Amivest Dollar Index} = \frac{\text{Co. Amivest Dollar Index (May)}}{\text{Market Amivest Dollar Index (May)}}$$

As an example, the unadjusted dollar index for American Can during May, 1969, was \$958,497 and the comparable market index was \$1,706,557. Therefore, the *relative* dollar Amivest index for American Can was .562, indicating that American Can's dollar liquidity during May, 1969, was about 56 percent as large as the average stock on the NYSE. A comparable calculation with American Can's share index and the market share index shows a relative share value of .51 indicating that American Can's share liquidity was about one-half as large as the share liquidity for the average stock on the NYSE.

The relative liquidity measures for individual stocks are employed in the next section where there is a comparison of the market liquidity for a sample of larger firms to the liquidity for a sample of smaller firms.



## LARGER FIRMS VERSUS SMALLER FIRMS

### Sample Firms

The total sample was derived as part of a larger study that considered external and internal liquidity using quarterly financial statements. Therefore, the larger firm sample includes 24 firms that provided quarterly financial statements (balance sheet and income statements) for the seven years 1969-1975. The companies also had to be on Compustat and on the University of Chicago stock price tapes (CRSP tapes). Even with these constraints, the list includes the three largest industrial firms on the Fortune 1975 top 1000 industrial list (Exxon, General Motors, and Ford). There were only five companies that would not be in the top 100 (United Airlines was second on the transportation list but would have been about number 75 on the industrial list; Jewel Companies were 11th on the retailing list and would have been 80 on the industrial list). The smallest company in this sample was Amsted with a rank of 360. The sample of smaller firms was randomly selected from the 50 smallest firms on the Fortune 1000 list that likewise had data available on Compustat and CRSP.

Clearly the sample of larger firms is generally the largest available in our economy since they are near the top of the Fortune list. In contrast, the sample of "smaller" firms are not small in absolute terms since they are still part of the Fortune list, but are definitely smaller than the large group. As an example, the 1,000th company on the 1975 Fortune list was Seagrave. This company had sales of over \$91 million and assets of over \$57 million. In absolute terms this firm is not small, but it is small compared to Exxon (number 1 in 1975) that had sales of \$42 billion

It is noted that the above information is not to be considered

extended and beyond the limits of the industrial structure.

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and assets of \$31 billion. The point is, the smaller company sample is small compared to the larger firms, but still much larger than a number of other public firms which number close to 10,000. Therefore, they are smaller than the large firms, but larger than about 9,000 other firms.

### Overall Individual Stock Results

An examination of the liquidity values for the two samples in Exhibits 3 and 4 indicates three relevant observations. First, the relative values vary widely between individual firms within a group (larger firms or smaller firms) even though the firms in a sample are quite comparable in terms of company size as shown in the Fortune list. As an example, during 1969 the relative dollar indexes for the large firm sample ranged from .07 for Amsted to 7.14 for Atlantic Richfield. If one ignores Amsted as being too small, the low value becomes .35 and the high to low ratio is over 20 times.

The second observation is that the liquidity values for individual stocks vary substantially *over time*. This is impressive considering that these are *relative* measures and as such should not be affected by market changes. As an example, the Eastman Kodak relative dollar index ranged from 1.94 in 1969 to 30.92 in 1973--a factor of over 15. Finally, it is apparent that the relative dollar indexes and relative share indexes for individual companies during specific years are generally quite similar. Put another way, the alternative liquidity measures for individual stocks clearly move together over time.

### Comparisons

The purpose of the subsequent comparisons is twofold. The first intent

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less and larger the amount of dilution

two for the two shares of the smaller  
this is a general principle of dilution  
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EXHIBIT 3

RELATIVE MEASURES OF EXTERNAL MARKET LIQUIDITY  
FOR 24 LARGE FIRMS (DOLLAR AND SHARES)

COMPANY	1969		1970		1971		1972		1973		1974		1975	
	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs
American Can	.56	.51	1.31	1.14	.64	.70	.71	.84	1.50	1.46	.44	.43	.64	.53
American Hospital & Supply Co.	.37	.53	1.53	1.50	.68	.91	1.09	.95	2.61	2.32	1.25	1.07	.82	.67
Amsted Industries	.07	.08	.29	.29	.09	.10	.10	.10	.15	.13	.29	.22	.92	.44
Atlantic Richfield Co.	7.14	2.87	9.36	4.30	2.79	1.60	9.15	5.60	7.92	3.51	8.27	2.47	8.13	2.62
Caterpillar Tractor	1.12	1.06	2.09	1.86	.53	.45	1.54	1.11	5.38	3.19	5.21	2.65	6.98	3.14
Chrysler Corp.	1.10	1.08	4.18	5.89	1.43	2.00	1.57	1.79	4.46	5.58	.90	1.05	.81	1.22
John Deere	.87	.95	2.16	1.91	.92	.50	1.06	.66	2.13	1.91	1.58	1.51	3.45	2.28
Eastman Kodak	1.94	1.27	12.50	6.21	5.59	3.06	7.24	2.37	20.52	8.58	18.33	5.37	11.59	3.22
Exxon Corp.	4.46	2.74	16.34	9.96	6.19	3.50	6.62	3.59	32.50	12.46	10.45	4.15	7.71	2.77
Ford Motor Co.	2.14	2.12	7.79	6.06	1.09	1.36	3.89	2.25	9.49	5.78	6.17	3.70	3.91	3.10
General Motors Corp.	5.20	5.23	15.46	7.84	6.41	3.33	9.47	4.73	20.53	10.74	10.24	6.41	7.38	4.60
Georgia Pacific	1.28	.65	5.61	4.14	1.71	1.42	.85	.63	1.70	1.68	2.54	1.72	1.71	1.02
International Harvester	.50	.90	1.72	2.20	.53	.69	.65	.79	1.33	1.75	.64	.74	1.35	1.35
International Paper	1.51	1.71	2.13	2.25	1.11	1.22	1.32	1.26	2.73	2.66	2.88	1.92	2.37	1.37
Jewel Companies	.35	.34	1.23	.98	.42	.32	.47	.33	.36	.31	.46	.33	.34	.31
Monsanto	1.14	1.17	2.98	2.76	1.64	1.57	1.58	1.14	3.12	2.18	13.02	6.11	6.27	2.78
Motorola	.74	.31	3.26	1.31	1.58	.85	2.21	.82	3.08	1.11	3.57	1.87	3.88	2.25
Proctor and Gamble	1.48	.83	3.87	1.53	2.33	1.69	2.17	.91	8.38	3.06	7.40	2.35	5.61	1.75
Quaker Oats	.35	.30	.70	.56	.51	.53	.41	.27	.58	.52	.36	.42	.33	.54
A. E. Staley	.23	.26	.53	.41	.07	.07	.11	.11	.21	.19	.17	.13	.40	.17
Standard Oil Co. (CAL)	2.90	2.04	10.28	7.13	1.83	1.33	2.59	1.63	5.51	2.58	3.83	2.98	1.74	1.88
Standard Oil Co. (IND)	2.78	2.09	4.22	2.69	1.55	1.10	2.10	1.27	15.80	6.53	6.46	2.39	2.87	1.82
Union Oil Co.	1.91	1.67	2.51	2.35	.83	.75	1.01	.94	1.90	1.60	1.28	.93	1.79	1.24
United Airlines	.71	.95	1.90	1.79	.57	.67	1.02	.81	.73	1.18	1.36	1.49	.81	1.05

RESEARCH REPORT ON THE PROGRESS OF THE  
PROJECT DURING THE YEAR 1958

NO.	NAME	SEX	AGE	REL.	EDUC.	PROF.	IND.	AGRI.	OTHER	TOTAL
1	JOHN	M	25	H	HS					
2	MARY	F	22	W	HS					
3	JOHN	M	20	S	HS					
4	MARY	F	18	D	HS					
5	JOHN	M	15	S	HS					
6	MARY	F	12	D	HS					
7	JOHN	M	10	S	HS					
8	MARY	F	8	D	HS					
9	JOHN	M	5	S	HS					
10	MARY	F	3	D	HS					
11	JOHN	M	2	S	HS					
12	MARY	F	1	D	HS					
13	JOHN	M	0	S	HS					
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EXHIBIT 4

RELATIVE MEASURES OF EXTERNAL MARKET LIQUIDITY  
FOR 24 SMALLER COMPANIES (DOLLAR & SHARES)

COMPANY	1969		1970		1971		1972		1973		1974		1975	
	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs	\$	Shrs
American Shipbuilding	.02	.04	.05	.09	.05	.04	.05	.05	.05	.10	.07	.18	.03	.07
Bates Mfg. Co.	.01	.02	.02	.06	.01	.04	.01	.03	.01	.03	.01	.03	.24	.29
Belding Hemingway	.02	.04	.05	.08	.03	.04	.04	.08	.02	.05	.04	.08	.01	.02
Carter Wallace	.07	.18	.27	.50	.66	.17	.18	.30	.06	.14	.06	.13	.07	.15
Cleveland Cliffs	.02	.02	.09	.07	.68	.05	.08	.05	.18	.11	.27	.11	.54	.16
Cox Broadcasting	.09	.09	.07	.13	.07	.11	.33	.32	.11	.12	.07	.08	.08	.10
Dentsply Inc.	.13	.12	.25	.20	.44	.44	.25	.21	.11	.13	.19	.19	.32	.27
Dr. Pepper Co.	.07	.06	.24	.46	.09	.14	.29	.23	.52	.80	.27	.47	.29	.57
Fansteel Inc.	.04	.09	.06	.16	.01	.04	.08	.18	.03	.07	.06	.09	.04	.06
Hayes-Albion	.01	.02	.04	.08	.02	.04	.03	.05	.02	.05	.02	.03	.02	.03
Holly Sugar Corp.	.01	.02	.04	.08	.03	.09	.01	.03	.03	.05	.12	.20	.15	.15
Keller Industrials Inc.	.04	.07	.09	.12	.02	.04	.07	.11	.05	.12	.05	.07	.01	.03
Kroehler Manufacturing Co.	.02	.02	.05	.10	.02	.02	.03	.03	.02	.04	.03	.04	.01	.01
Lehigh Valley	.08	.31	.11	.42	.63	.13	.06	.19	.10	.23	.14	.34	.09	.22
Lessona Corp.	.14	.14	.06	.13	.04	.05	.02	.05	.09	.10	.09	.07	.07	.07
MacAndrews-Forbe	.03	.07	.07	.14	.03	.05	.03	.04	.04	.06	.05	.04	.02	.03
Marquette Cement	.03	.08	.08	.17	.05	.12	.02	.07	.06	.16	.05	.09	.05	.07
Monsingwear Inc.	.04	.06	.02	.09	.03	.03	.03	.04	.05	.06	.06	.05	.05	.05
Pitt Forgings	.01	.04	.07	.14	.01	.03	.01	.03	.03	.06	.04	.07	.01	.02
Skil Corp.	.02	.02	.05	.05	.03	.05	.03	.10	.10	.11	.02	.03	.01	.02
Stanway Corp.	.07	.13	.10	.18	.04	.08	.05	.09	.03	.09	.10	.12	.05	.08
Storer Broadcasting	.14	.17	.24	.31	.09	.12	.37	.35	.25	.43	.12	.14	.12	.15
Texas Industries Inc.	.05	.08	.15	.17	.03	.04	.08	.10	.09	.11	.05	.06	.04	.05
Thomas and Betts	.05	.05	.24	.21	.17	.15	.12	.07	.48	.20	.45	.33	.14	.10

STATE OF MASSACHUSETTS  
DEPARTMENT OF REVENUE

DATE	DESCRIPTION	AMOUNT	TOTAL
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is to determine if there are *any differences* in the level of market liquidity for small versus large firms. The second purpose is to determine if there ~~has been~~ any difference in the *trends* of liquidity over time. Specifically, have the liquidity values for large and smaller firms moved in parallel over time or has there been a change in the performance of one group relative to the other?

Regarding the differential level of liquidity it was expected that on average the large firms would have a higher level of liquidity than the smaller firms because they have more shares outstanding, they are better-known, and generally experience more trading activity. The expectation for the analysis of differential trends is related to the notion of a tiered market. It has been observed during the past ten years that because of the growth of institutions and the increase in their trading turnover, they have come to dominate trading in the secondary equity market [1, 3]. Further, institutions prefer large firms because of their liquidity [8]. Hence, a "tiered market" has evolved with large firms in the upper tier and the great bulk of smaller firms comprising the lower tier [5, 10]. The result of the tiered market in terms of liquidity is that the rich get richer and the poor get poorer. Specifically, one would expect in a tiered market that the large firms that are of interest to the institutions that dominate trading would become *more* liquid, while the smaller firms in the lower tier would either experience *no change* in liquidity or might even show a *decline* in their market liquidity over time. Therefore, it was hypothesized that there would be a divergence in the liquidity for the two groups over time.

The first of these is the fact that the  
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### Differences in the Level of Liquidity

The analysis considered the average liquidity for the two samples of stocks over time. The results reported in Exhibit 5 clearly support the belief that *there is a major difference in the relative liquidity for the large firms compared to the smaller firms*. In fact, the differences were substantially larger than expected. In terms of the relative dollar liquidity measures, the large firms are over 30 times more liquid than the smaller firms. In terms of the relative share liquidity measures the large firms are over 15 times more liquid.

The difference in comparison for the two measures is interesting. This difference occurs because the dollar index for the larger firms is generally twice as large as the share index for these firms. In contrast, for the smaller firms the share index is larger than the dollar index. This seeming paradox can be explained by the differential price of the shares for the two sets of firms. The average share price for the large firms is in excess of \$50, while the average share price for the smaller firms is about \$25. Therefore, the large firms have greater share liquidity, i.e., they can sell about 15 times more shares for a given percent change in price than the smaller firms. Then, considering the price of the shares for the larger firms is about twice the share price of the small firms, the dollar values indicate an investor in a large firm can buy or sell 30 times as many dollars of stock for a given percent change in price as an investor in a smaller firm.

Because of the possible price bias connected with the share index, most observers would probably agree that the dollar index is preferable for comparing two groups of stocks. The point is, *irrespective of which*

Diffusion in the Tropics

The diffusion of heat and moisture in the tropics is a complex process involving both horizontal and vertical transport. In the tropics, the primary energy source is solar radiation, which is most intense near the equator. This leads to a significant temperature gradient from the equator towards the poles, driving atmospheric circulation.

Horizontal diffusion is dominated by wind-driven transport. The trade winds in the tropics facilitate the movement of air and moisture from the equatorial region towards the subtropics. This process is crucial for the distribution of heat and the maintenance of the tropical climate.

Vertical diffusion is also significant, particularly in the form of convection. In the tropics, the air near the surface is heated, causing it to rise. As the air rises, it expands and cools, leading to the formation of clouds and precipitation. This vertical transport is a key mechanism for redistributing energy and moisture from the surface to the upper atmosphere.

The combination of horizontal and vertical diffusion processes in the tropics results in a highly dynamic and moist atmosphere. The intense solar heating and the resulting circulation patterns are responsible for the characteristic weather and climate of the tropical regions.

Understanding the diffusion of heat and moisture in the tropics is essential for climate modeling and predicting future climate changes. The complex interactions between the surface, the atmosphere, and the oceans in the tropics make it a challenging area of study.

EXHIBIT 5

AVERAGE RELATIVE LIQUIDITY VALUES  
FOR LARGE AND SMALLER FIRM SAMPLES

	Dollar Index			Share Index		
	Large	Small	Ratio L/S	Large	Small	Ratio L/S
1969	1.705	.050	34.1	1.236	.081	15.3
1970	4.715	.107	44.1	3.256	.173	18.8
1971	1.709	.061	28.0	1.259	.089	14.1
1972	2.455	.097	25.3	1.454	.116	12.5
1973	6.796	.105	64.7	3.359	.144	23.3
1974	4.463	.101	44.2	2.175	.127	17.1
1975	3.409	.103	33.1	1.756	.116	15.1





*liquidity series is used*, the results support the expectation that the external market liquidity for larger firms is *significantly greater* than the market liquidity for smaller firms. Relating these results to the selection of the sample, it should be noted that the results would probably be more divergent if the larger firm sample had been confined to the top 50 firms. As it is, the sample only contains three of the top 13 stocks in terms of liquidity (General Motors, Eastman Kodak, and Exxon); but it is missing such notable institutional favorites as IBM (the most liquid stock) and AT&T.

#### Changes in Liquidity Over Time

The data in Exhibit 5 indicate what happened to the average liquidity for the two groups of individual sample firms over time. It was hypothesized that the relative liquidity for the larger firms would probably increase over time because of the increased trading by institutions and their desire to acquire larger firms. In contrast, it was expected that the liquidity for smaller firms would generally remain constant or possibly decline because the dominant institutions would generally not have an interest in these firms. Therefore, one would expect that a ratio of the average liquidity values would increase over time assuming the ratio was the relative liquidity value for the large firms divided by the average relative liquidity value for the smaller firms.

#### Averages Over Time

The figures in Exhibit 5 indicate that the average liquidity values for both samples and measures generally *increased over time*. Specifically,

It is important to note that the results reported in the preceding table  
 are based on the assumption that the market is in equilibrium. It is  
 therefore possible that the market is not in equilibrium and that the  
 results reported in the preceding table are biased. This possibility  
 is discussed in more detail in the following section.

Changes in the market

The results in Exhibit 2 indicate that the average liquidity  
 for the two groups of individual stocks is not significantly  
 different. This result is consistent with the hypothesis that the  
 market is in equilibrium. The fact that the average liquidity for  
 the two groups of individual stocks is not significantly different  
 suggests that the market is in equilibrium. This result is consistent  
 with the hypothesis that the market is in equilibrium.

Conclusion

The results in Exhibit 2 indicate that the average liquidity  
 for the two groups of individual stocks is not significantly  
 different. This result is consistent with the hypothesis that the  
 market is in equilibrium.

the average dollar index for large firms went from 1.705 in 1969 to a high of 6.796 in 1973 and ended in 1975 at 3.409--double the 1969 value. Similarly, the average dollar index for the small firms went from .05 in 1969 to about .10 in 1975. Notably, the relative measures for both samples were high during 1973 and 1974 which were periods of declining stock prices and generally low market liquidity as shown earlier. The relative measures for these two samples increased because the liquidity for both groups of firms likewise declined, but the decline was not as severe as for the aggregate market. Notably, the relative performance by the larger firms during this period of declining stock prices was superior to the performance by smaller firms.

#### Ratio Over Time

The performance of the large to small liquidity ratio over time was not consistent with expectations based upon the development of a tiered market. The time series plot shown in Exhibit 6 indicates that the ratio of the average relative liquidity measures varied over time and ended the period slightly lower than at the beginning of the period. Notably, this ratio declined during 1971 and 1972, and increased during 1973 and 1974. This would indicate that the differential between large and smaller firms varied by market period. Specifically, during rising markets such as 1971 and 1972 the relative liquidity for the smaller firms increased more than for the larger firms. In contrast, during declining markets, the market liquidity for smaller firms declines much more than that for larger firms.

Although the average relative liquidity data do not support the

The average dollar index for the period 1954-1964 was 100. The average dollar index for the period 1965-1974 was 100. The average dollar index for the period 1975-1984 was 100. The average dollar index for the period 1985-1994 was 100. The average dollar index for the period 1995-2004 was 100. The average dollar index for the period 2005-2014 was 100. The average dollar index for the period 2015-2024 was 100.

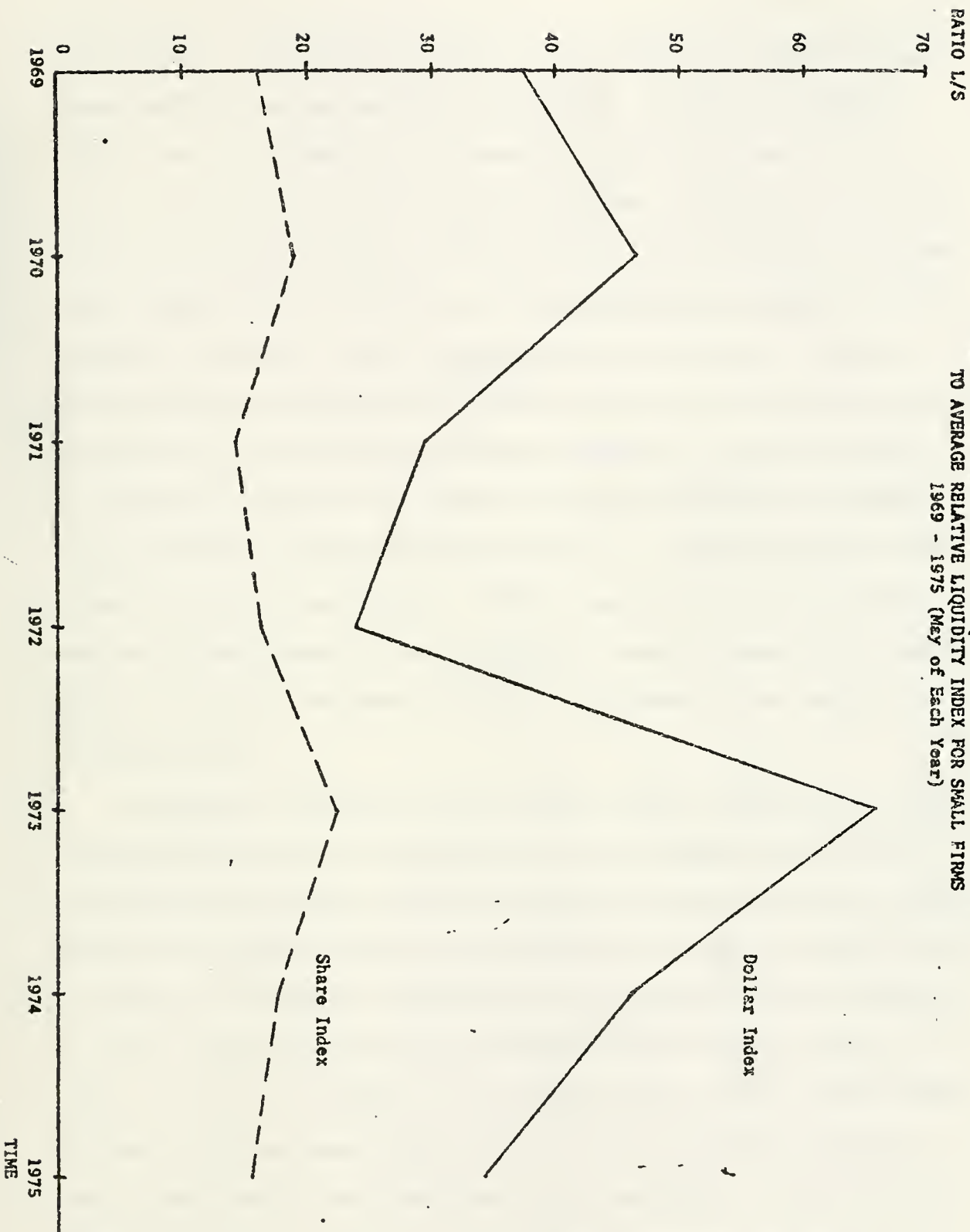
The average dollar index for the period 1954-1964 was 100. The average dollar index for the period 1965-1974 was 100. The average dollar index for the period 1975-1984 was 100. The average dollar index for the period 1985-1994 was 100. The average dollar index for the period 1995-2004 was 100. The average dollar index for the period 2005-2014 was 100. The average dollar index for the period 2015-2024 was 100.

The average dollar index for the period 1954-1964 was 100. The average dollar index for the period 1965-1974 was 100. The average dollar index for the period 1975-1984 was 100. The average dollar index for the period 1985-1994 was 100. The average dollar index for the period 1995-2004 was 100. The average dollar index for the period 2005-2014 was 100. The average dollar index for the period 2015-2024 was 100.

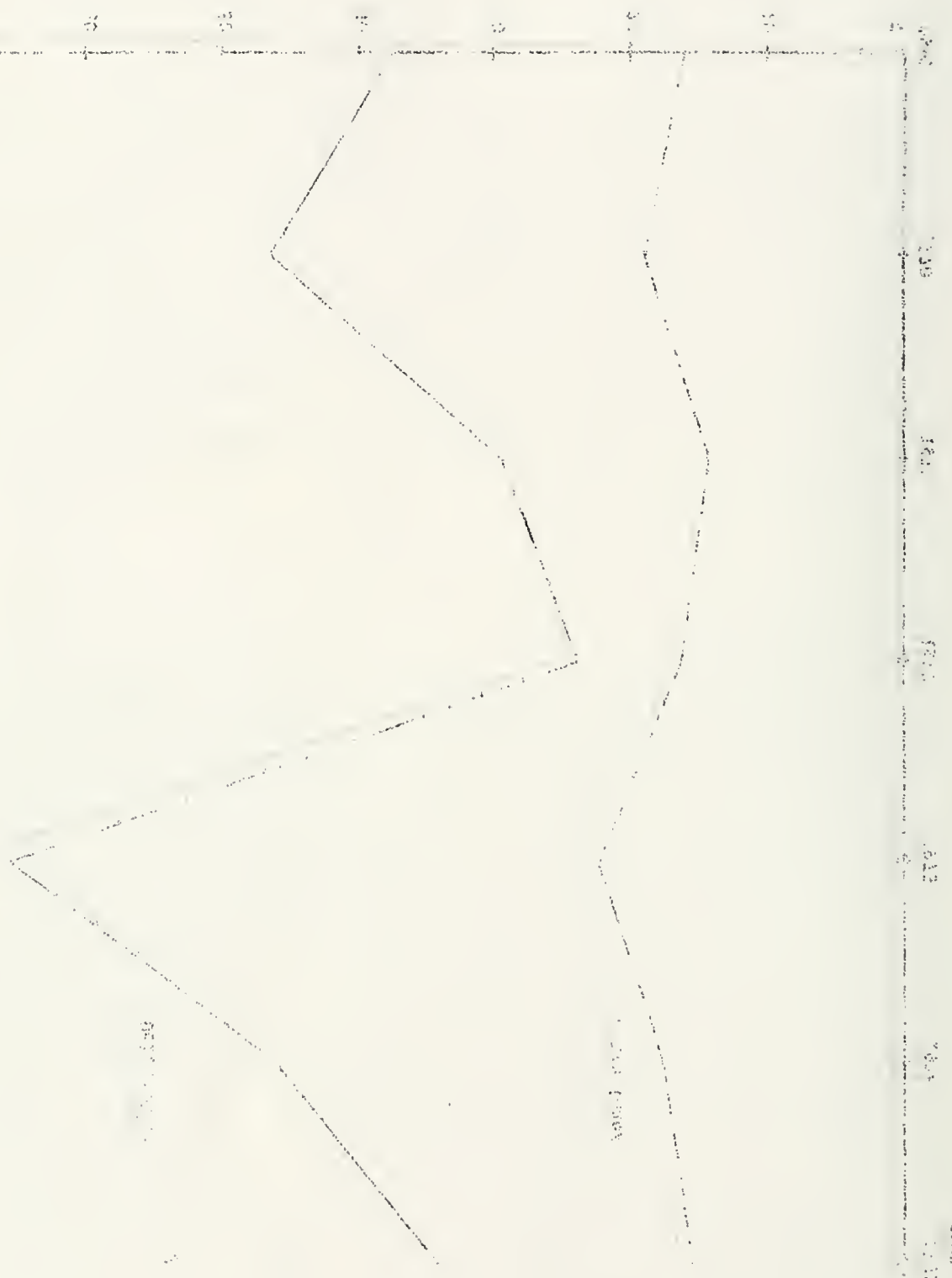
Although the average dollar index data do not support the

EXHIBIT 6

RATIO OF AVERAGE RELATIVE LIQUIDITY INDEX FOR LARGE FIRMS  
TO AVERAGE RELATIVE LIQUIDITY INDEX FOR SMALL FIRMS  
1969 - 1975 (May of Each Year)



THE STATE OF TEXAS,  
COUNTY OF [illegible]  
I, [illegible], County Clerk, do hereby certify that the within and foregoing is a true and correct copy of the original as the same appears in the records of the County Clerk's office.



[illegible]

[illegible]

expectations, a more detailed analysis of the results for the individual firms provides some support for the hypothesis. Referring to Exhibits 3 and 4, one can determine what happened to individual firms over time, i.e., how many of the firms experienced changes? An analysis of only the first and last years (1969 and 1975) indicates that within the large firm sample (Exhibit 3) 15 of the firms clearly experienced increases in both measures of liquidity; only 3 experienced definite declines, and 6 had mixed results where one liquidity measure increased and the other declined. In contrast to these consistent increases within the large firm sample, the individual results for the smaller firm sample (Exhibit 4) indicated that only 8 firms experienced clear increases, 9 experienced definite declines, and 7 had mixed results. Notably four of the smaller companies that experienced increases had very large increases. Clearly, the results within the smaller firm sample are not as consistent as the results for the larger firms.

In summary, an analysis of the relative market liquidity for a sample of large firms and small firms indicates a wide difference in the level of liquidity--the average large firm had about 30 times more market liquidity than the average small firm on the basis of the dollar liquidity index. An analysis of changes in liquidity over time indicated that both samples of stocks experienced increases in liquidity for the overall period. In fact, the ratio of liquidity for the large versus the small indicated that the small firms increased slightly more from the first year to the last year. These results were inconsistent with expectations. Two points are worthy of note. First, the ratio of liquidity measures declined during rising markets and increased sharply during declining markets. This





indicates that the small firms gain in terms of relative liquidity during good markets, but suffer declines in relative liquidity during declining markets. Second, the individual firm results differed. The individual results for the large firms indicated that almost all of the large firms experienced an increase from 1969 to 1975. In contrast, only one-third of the small firms experienced an increase--apparently the average results for the smaller firm sample were carried by several very large increases.

### CONCLUSIONS

The ability to buy or sell stock quickly without major price changes is obviously of importance to portfolio managers and investors because of its effect on the variability of returns. It is also of importance to corporate managers because it affects the company's ability to acquire new external equity capital and can influence the required return on the firm's equity.

The results reported here indicate several generalizations:

- 1) Aggregate market liquidity is very volatile over time.
- 2) The market liquidity for individual securities differs depending upon whether it is measured as dollar liquidity or share liquidity, but the two measures move in parallel over time.
- 3) The liquidity measures for individual securities vary substantially over time--even when adjusted for changes in market liquidity (i.e., relative liquidity varies).
- 4) There is a substantial difference in the level of liquidity for a sample of larger firms compared to a sample of smaller firms.
- 5) Apparently the liquidity for both samples has increased over time,

indicated that the small  $\bar{Y}$  was not in fact a statistically significant  
 difference between the two groups. The fact that the difference  
 between the two groups was not statistically significant is  
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 results of the present study, the difference between the two groups  
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 between the two groups was not statistically significant is not  
 surprising in view of the fact that the difference between the  
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DISCUSSION

The results of the present study indicate that the difference  
 between the two groups was not statistically significant. The  
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 statistically significant.

but the larger company results are more consistent and the larger firms tend to gain during declining markets when market liquidity is of greatest importance.

The first column shows the number of  
 items in each class. The second column  
 shows the number of items in each class  
 multiplied by the class interval. The  
 third column shows the number of items  
 multiplied by the square of the class  
 interval. The fourth column shows the  
 number of items multiplied by the cube  
 of the class interval. The fifth column  
 shows the number of items multiplied by  
 the fourth power of the class interval.

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