Information Use and Transference Among Legally Separated Share Markets:

An Experimental Approach

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Abstract

Several emerging capital markets have adopted legally separated share markets (LSSM) in which local firms market separate claims to the same underlying dividend flow to two distinct sets of investors, domestic citizens and foreigners. Legal restrictions prevent arbitrage across these markets. But field studies document covariance in the price movements of these assets. The natural explanation for the covariance in price movements is that the price movements in one market reveal information that is relevant to traders in the other market. A laboratory experiment is conducted to test the hypothesis that both (i) the price of an asset that is traded in a market where there are some "informed" traders will reflect that information and (ii) the price of an asset with the same state-dependent dividend that is traded in a legally separated market with no informed traders will also reflect the same information. We find that the information held by insiders does get reflected in the prices in both markets. There is a lag in information transfer to the market in which there are no insiders. The effectiveness of the transference of information depends on whether or not the location of the informed traders is public knowledge and on the quality and clarity of the signal imbedded in the price movements in the market in which the informed traders participate.

Key words: Asset pricing, information transfer, rational expectations, market efficiency and legally segmented share markets.

JEL Codes: C92, G12, G14

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1. Introduction

Foreign share ownership restrictions have been a common practice at different times in almost all emerging capital markets.[1] They come in various forms to protect domestic industries while serving the purpose of attracting foreign capital. Several countries with emerging capital markets have adopted legally separated share markets (LSSM) in which local firms can market separate claims to the same underlying dividend flow to two distinct sets of investors, domestic shareholders who can buy "*A*" shares with domestic currency and foreign investors who can only buy "*B*" shares with foreign currency. For example, in China, local firms issue "*A*" shares to Chinese citizens who can only trade "*A*" shares with Chinese currency, Yuan;[2] firms can also issue "*B*" shares to foreign investors who can only trade "*B*" shares with U.S. currency.[3] "*A*" and "*B*" shares carry the same economic and voting rights.

As an empirical fact, prices of these assets diverge. This would provide arbitrage opportunities if there were no legal restrictions of the trading of these assets. However, restrictions on the percentage of capital that can be raised by the sale of "*B*" shares, together with prohibition of foreigners purchasing "*A*" shares and of domestic investors buying "*B*" shares prevent any opportunity for arbitrage across these two market claims

[1] For example, the Restrictions Act of 1939 significantly limited foreign shareholdings in Finnish companies. The law differentiated between restricted shares, which only Finns were permitted to own, and nonrestricted shares, which were available to foreigners. Philippine stock market and Mexican stock market also have different restrictions on foreign share ownership at different times.

[2] Since February 19, 2001, Chinese investors who already had a foreign currency savings account were also allowed to trade "B" shares. Most countries with LSSM design in their capital markets relax restrictions on foreign share ownership gradually. Our study is based on the initial forms and features of LSSM where there is still strict separation between domestic and foreign investors.

[3] "B" shares listed in Shanghai Stock Exchanges are traded with U.S. currency while "H" shares listed in the other stock exchange in China – Shenzhen Stock Exchanges are traded with Hong Kong dollars.

to the same dividend flow.[4] Nevertheless, previous studies have documented the covariance in *A* and *B* shares' price movements (Kim and Shin 2000, Chui and Kwok 1998, and Chakaravarty, Sarkar and Wu 1998). This has led a number of scholars to attempt to provide an explanation for the difference in pricing of these two classes of shares and the share price co-movements. Empirical work with field data using implications of CAPM models (Fernald and Rogers 2002) has attempted to account for the divergence in prices of "*A*" and "*B*" shares on the basis of difference in risk premiums. This approach implies that the difference in risk premiums should be the same across different companies. However, this implication is not consistent with empirical data[5]. Furthermore, because these markets are legally separated, traders in these different markets may have different optimal portfolios even if they have the same risk attitudes. Consequently, there is no theoretical reason to expect that "*A*" and "*B*" shares will be priced identically.[6]

While there are good theoretical reasons to believe that shares traded in LSSM need not have the same price level in equilibrium, what remains to be explained is the covariance observed in the price movements of these shares. It is this phenomenon to which this research is directed.

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[4] However, there have been reports indicating domestic capital flows trading "B" shares. Chinese citizens can ask overseas relatives to open an account to trade "B" shares. But there is no close estimate of the scale of such activities.

[5] See Li Qi (2004), section 3.4.1, "Three Essays on Emerging Capital Markets," Unpublished Dissertation, University of Pittsburgh.

[6] Optimal portfolio theory implies that the price of any one share depends not only upon its own dividend flow but also upon the characteristics of the dividend flows of other assets that individuals may purchase. Since foreign investors and domestic investors have distinct sets of assets from which they can compose their portfolios, optimal portfolio theory provides a basis for accounting for differences in the prices for "A" shares and "B" shares. Although it is difficult to implement purely empirical tests on this hypothesis, there has been some experimental evidence to support the prediction of asset pricing of optimal portfolio theories. For example, Bossaerts, Plott and Zame (2003) show that asset prices are consistent with the predictions of portfolio theories (although portfolio choices diverge from choice predictions of the same theories).

Traders in LSSM may not value the same dividend flows in the same way, but they are both equally interested in the dividend flows. Generally those dividend flows are, at best, known probabilistically. However, some individuals may have better information than others as to the nature of this dividend flow. Therefore, all traders may be attempting to infer what the best information is from price movements in *both* markets. Indeed the market efficiency hypothesis implies that in equilibrium, the price of "*A*" and "*B*" shares will fully reflect the best available information. It is this hypothesis that we wish to test.

2. Research Motivation

Studies that empirically identify the correlation between "*A*" and "*B*" share price co-movements (Kim and Shin 2000, Chui and Kwok 1998) have attempted to identify lead-lag relationship as a way of suggesting the direction of information flow. For example, Chui and Kwok (1998) use daily prices of "*A*" and "*B*" shares and demonstrate the lead-leg effect between these two types of shares is robust. They explain their findings as follows: "since *B*-share investors have better information than *A*-share investors, the latter tend to gain more information from the trading of *B* shares for the same stock. The direction of information flow is mainly from the price of *B* shares to the price of *A* shares. As a result, the returns on *B* shares lead the returns on the *A* shares."

Although this explanation is plausible it is difficult to test with field data because the outside observer does not know what information about the underlying fundamentals that determine future dividend flows is possessed by the various traders in the asset markets. Thus, due to the limitations inherent in the field data studies, the explanation for the lead-lag relationship mentioned above is inevitably conjectural.

However, in a laboratory experiment the "fundamentals" which, according to asset pricing theory, determine asset prices are chosen by the experimenter and can be used directly in testing hypotheses about asset pricing. For this reason, we utilize laboratory experiments in which the experimenter knows the actual distribution of information among market participants to study the use and transference of information across legally separated share markets.

3. Literature Review

The test of our hypothesis on the impact of how information that might appear in one market gets transmitted to another market is a test of market efficiency. The price co-movement phenomenon is closely related to the hypothesis that the market price reflects the best available information, which is the central implication of the claim that asset markets are efficient. There has been some experimental support for this claim.

Previous experimental studies with regard to information transmission in a single market (that is, a single group of traders) have focused on two types of situations: one is that information "insiders" hold perfect knowledge of what the state will be; the other is that no individual knows exactly what the true state is but if private information were aggregated, the true state will be revealed.

Plott and Sunder (1982) conducted an experiment in which a market currency could be traded for a one-period asset. The dividend paid to a holder of a unit of this asset at the end of a trading period depended on both the agent's type and on the realization of a state variable drawn from a commonly known distribution of possible values. The value of the state variable was drawn at the beginning of the trading period and was made known to a fraction of all traders ("insiders"). If the information possessed by the insiders did not 'leak' out to the market as a whole then the prices at which the asset traded would be independent of the true state. Conversely, if the information held by the informed traders were fully reflected in the market price for the asset then the market price would vary with the value of the state variable and all of the stock of the asset would tend to be held by that type of agent who received the highest dividend payoff when that state was realized. Plott and Sunder found that, as subjects gained experience, market prices tended to track the fully revealing rational expectations equilibrium prices and that asset holdings also tended to be concentrated in the hands of those agents who had the largest realized state-dependent dividends.

In the case of partial private insider information, information aggregation is observed under some, but not all conditions. Plott and Sunder (1988) studied markets where traders had different information and the information structure was collectively complete; that is, traders' collective information completely identified each trader's payoff. In sessions where only one asset is traded they found no evidence of information aggregation. However, when there was a complete set of Arrow/Debreu securities that could be traded, information aggregation took place. In the Plott and Sunder (1988) experiments each subject knew only his own payoff function. Forsythe and Lundholm (1990) examined the extent to which markets actually aggregate and transmit information when there is common knowledge of the payoff functions for all types of agents and when every subject is given the opportunity to play all roles. They find that common trading experience and common knowledge of dividends are jointly sufficient to achieve a rational expectation equilibrium when a single asset is traded and aggregate information is complete. But information aggregation does not work well in complicated environments. Studies extending the possible number of states governing dividend payoffs (O'Brien and Srivastava 1991 tested information aggregation with six possible states), and number of securities simultaneously traded fail to observe information aggregation. Moreover, recent studies also show the possibility of "information trap" – a sort of equilibrium in which information existing in the market does not become revealed in prices (Noeth, Camerer, Plott and Webber 1999). These efforts are designed to test the limits of the market information aggregation. Most of the extensions have been in the direction of reaching more complicated environments such as number of possible states and securities.

The process and impact of information revelation (or aggregation) *across* segmented markets, which applies to many markets in real economies, have not been studied. Will the power of simple environments, in which information transmission has been proved to exist, also support information transmission across separated markets where assets have claims to the same dividend flow? This is the question to which our experiment is addressed.

4. Experimental Design

4.1. The Environment

We recruited subjects for a computerized double auction asset market game. The subjects were divided into two groups: the *domestic (A)* player group and the *foreign* (*B*) player group. Members of each group trade amongst themselves, but cannot trade with members of the other group. While a given subject can trade in only one of the markets, all subjects see on their screens the activity in both markets.

In this experiment, each group has two assets: one asset, labeled either '*A*' or '*B*,' pays a state-dependent dividend**.** The other asset is a trading currency that pays a dividend independent of state. At the beginning of a trading period each subject is endowed with 10 units of stock (either *A* or *B*, depending on which group to which they belong) and 3500 units of trading currency. Each asset pays its dividend at the end of each trading period. Each asset has a one period life. At the end of a market period the assets have no redemption value. The stochastic process generating the state at the end of each trading period is public knowledge, as is the state-dependent dividend paid by each asset to each type of trader. In each market, there are two different types of traders who are distinguished by the different payoffs received for the realized state. It is common knowledge that the distribution of types of subjects is the same in both groups. Therefore, the fully revealing equilibrium is the same in both groups.

Table 1 shows the stochastic process and the payoffs paid for assets *A*, *B* and the trading currency for different types of traders in both groups.

[Insert Table 1 here]

The payoff function for an agent of type *i* in period *t* is

$R_i^t = \gamma_i[d_i(\theta)x_i^t + \sum_s P_s^{it} - \sum_p P_p^{it} + C_i^t]$, $d_i(\theta) > 0$, $\gamma_i > 0$, $x_i^t > 0$, where

R_i^t = dollar earnings of individual *i* in period *t*,

x_i^t = asset units held by *i* at the end of period *t*, which is the sum of initial endowment of assets plus purchases less sales in period *t*,

$d_i(\theta)$ = dividend paid in francs for individual *i* and expressed as a function of the state of nature θ,

$\sum_s P_s^{it}$ = revenue from sales of assets during period *t*,

$\sum_p P_p^{it}$ = cost of assets purchased during period t,

$\theta \in \Omega$ = possible states of nature,

C_i^t = initial endowment of cash in francs,

γ_i = conversion rate of francs into dollars.

The above dividend and payoff table and dollar redemption formula is public knowledge. By utilizing only two possible states and two types of traders the potential for an “information trap” is eliminated. The dividend paid to the assets for the two states is quite different from each other to reduce confusion.

The expected**,** full-revealing rational equilibrium asset prices and asset holdings are:

When *state I* occurs, price for asset *A* (*B*) is 300, Type *X* will hold asset *A* (*B*),

When *state II* occurs, price for asset *A* (*B*) is 50, Type *Y* will hold asset *A* (*B*).

However, in the rational expectations equilibrium without insider information the equilibrium asset price is independent of the realized state. The prior information equilibrium is:

price for asset *A* (*B*) is 162.5 and Type *X* will hold asset *A* (*B*).

4.2. Treatment Variables

The basic hypothesis motivating this experiment is that people trading in LSSM tend to read information from the price movements in one market as a relevant assessment of the fundamental factors of the asset they are trading in the other market. Therefore, the main treatment variable is the distribution of private information.

In the baseline treatment (*treatment 1*), it is common knowledge that no one knows which state will prevail at the end of a trading period when dividends are declared. That is, there are no traders with "insider information."

Our hypothesis is that in the baseline treatment in both markets price will converge to the prior information rational equilibrium price (162.5). While prices in both markets are expected to converge to the same equilibrium and, therefore, be correlated, absent inside information, there is no reason to expect any lead/lag structure in the correlation between the *A* and *B* price movements.

In a second condition (*treatment 2*), there is a set of "insider traders" in one market who are told at the beginning of each trading period what state will prevail at the end of the period. It is common knowledge that there are insiders, but their identities and the market in which they can participate is known only to the individuals who are provided with the inside information. With the existence of inside information, the hypothesis is that both markets will converge to the fully revealing rational expectations equilibrium. Because the location of the 'insiders' is unknown, our hypothesis is that there will not be a strong lead/lag pattern of co-movements of the price of "*A*" and "*B*" shares.

In the third treatment (*treatment 3*), subjects are not only aware of the existence of the insiders, but also of the location of the group (or market) to which insiders belong. Our hypothesis is that prices will converge in both markets to the fully-revealing equilibrium price and that the movement of prices in the market with the insiders will lead the movement of prices in the other market.

Table 2 describes the sessions we have run.

[Insert Table 2 here]

5. Experimental Results

5.1. Base Case: Treatment One (No Insiders)

Hypothesis 1: Price Convergence to Prior Information Equilibrium Prices

In this base treatment, no one has insider information. Therefore, the rational expectation equilibrium price is 162.5 for each trading period regardless of realized state and in equilibrium Type *X* traders should hold all of the stock.

Figure 1 reports the average transaction prices for assets *A* and *B* in each trading period in the two sessions we ran for treatment 1.

[Insert Figure 1 here]

In each of the graphs in Figure 1, the horizontal axis shows the trading periods in each session, and the vertical axis presents the price levels. The smooth line represents the predicted prior information equilibrium price and the other two lines with accentuated data points represent the average transaction prices for *A* and *B* in each trading period.

Although the average transaction prices for assets *A* and *B* never reached 162.5, they remain above the expected value (100) for Type *Y* traders. Furthermore, the average transaction prices were independent of the realized state.

Figure 2 shows the end of period holdings of stock by Type *X* traders. While competition amongst *X* types did not drive the price to the rational expectations equilibrium level, with experience it was sufficient to achieve a transfer of most of the stock to the Type *X* traders. The efficiency of the market can be measured by the ratio of the actual total dividends earned to the dividends that would have been earned in the prior information equilibrium. By this measure, the average efficiency in the base case was .875 in the *A* market and .885 in the *B* market.

[Insert Figure 2 here]

5.2. Markets with Traders That Have Inside Information

Hypothesis Two: When it is common knowledge that there are traders who know the true state, the market price in both markets will tend to converge to the fully revealing information equilibrium price.

5.2.1. Treatment 3 (Insiders in one market with location of insiders commonly known)

Figure 3 reports the average transaction prices and the predicted full-revealing equilibrium prices for the sessions we ran for Treatment 3.

[Insert Figure 3 here]

With experience, subjects reached the full-revealing equilibrium prices for almost all trading periods in all four sessions we ran for Treatment 3. The gap between the average transaction prices for *state I* and *state II* is getting larger and larger indicating that subjects were able to distinguish the two states and price assets accordingly as predicted by the full-revealing equilibrium. This trend is especially clear after period 10 for these 4 sessions.

Average transaction prices for asset *B* not only track the average transaction prices for asset *A*, but also converge to the full-revealing equilibrium prices as well. Since subjects in *B* market have no private insider information about the current state of the trading period, this is strong evidence that the insider information migrates into the *B* market. Informal interviews with subjects after each session confirmed that subjects in *B* market were watching the prices in *A* market closely and were able to successfully infer the true state of most trading periods.

While traders in the *B* market were able to extract information from the transaction prices in the *A* market, as Figure 4 shows, the end of period stock holdings in the A market conformed much more closely to the fully revealing equilibrium holdings than did the end of period holdings in the *B* market. This suggests that the passage of information from one market to the other had a significant effect on the timing and volume of trading in the market in which there were no informed traders. Consequently, the efficiency of the market with the inside traders, as measured by the ratio of actual dividends earned to the dividends that would have been earned in the fully revealing equilibrium is considerably higher than the efficiency of the market with no inside traders. In market *A* the efficiency was .940 while in market *B* it was .86.

[Insert Figure 4 here]

5.2.2. Treatment 2 (Insiders Whose Location is Unknown)

In this treatment the traders with inside information were in Market *A*. However, their location was private information.

Figure 5 shows the average transaction prices for each trading period for Treatment 2. The average trading price in the *A* market tracked the fully revealing information equilibrium price from the very first period. The *B* market's prices were distinctively different before and after period 7. Before period 7, *B* market prices stayed around a steady level that did not distinguish the two states. But after some trading experience and learning, *B* market started to move closer to fully revealing equilibrium prices.

[Insert Figure 5 here]

The lack of common knowledge of the location of traders with inside information also had a differential effect on the efficiency of the distribution of stock holdings. As Figure 6 shows, the end of period distribution of stock holdings conformed much more closely to the fully efficient pattern of holdings in Market *A*, where the traders with inside information were, in fact, located, than in market *B*. In Market *A*, subjects earned 91% of the dividends that could have been earned, while in Market *B* subjects earned only 83% of the available dividends.

[Insert Figure 6 here]

5.3. Lack of Information Transfer When Location of Insiders Was Common Knowledge

While information was generally transferred from market *A* to market *B* when it was common knowledge that the insiders were in market *A* this did not occur in all periods. In some periods in Treatment 3 the average of *B* prices reached the "wrong" state or simply did not follow the prices in *A* market.

It is useful to look at the within period dynamics in these cases to get a better understanding of the nature of information transfer.

Figure 7 plots the sequence of transactions in period 2 of the March 18 session. In this period, the true state was *I* and the fully revealing equilibrium price was 300. Informed traders in *A* were able to prevent their information from affecting the transaction prices in the market *A* until late in the session. Furthermore, after the first significant movement in the price in market *A* there was a long lull in trading in that market while a significant number of trades continued to be made in market *B* at a price in the neighborhood of the state *II* equilibrium price. It was only after a sequence of transactions in market *A* occurred that trended away from the state *II* equilibrium price that the transaction prices in market *B* began to follow.

[Insert Figure 7 here]

In period 2 of the 5/26 night session the true state was *I*. As shown in Figure 8, several trades were made in market *A* at prices in the neighborhood of the fully revealing equilibrium price. However, these were interspersed with transactions that occurred at much lower prices, so that there was no clear trend in the prices in market *A*. Absent a trend in market *A*, virtually all of the trades in market *B* took place as though no information was transmitted from market *A* to market *B*, even though all but two transactions in market *A* took place at much higher prices than in market *B*.

[Insert Figure 8 here]

Low volume of trade in market *A* also seemed to inhibit the transfer of information from that market, where there were informed traders, to market *B* where there were no informed traders. This is reflected in Figure 9 below.

[Insert Figure 9 here]

In both of these market periods displayed in Figure 9 the true state was *II*. While all of the transactions that occurred in market *A* were in the neighborhood of the fully revealing equilibrium price, early in the period there were very few transactions made in the *A* market. Transactions made in the *B* market appear to be unaffected by the *A* market transaction prices.

Because there are a small number of traders, it is possible for one or two traders in a market to engage in transactions that have a large effect on the average of the transaction prices in a market. This is reflected in the behavior of prices in market *B* in some periods in the 5/26 afternoon session. In periods 1 and 5 of that session the true state was II and the average transaction price in market *A* was in the neighborhood of the fully revealing equilibrium price. By contrast, the average transaction price in market *B* was at least three times the fully revealing equilibrium price. In period 1 of May 26 there were 26 trades with prices over 100 in market *B*. Out of these 26 trades, 7 were bought by subject 9 and 18 were bought by subject 10. These two individuals' transactions count for 25 out of 26 trades with price over 100. If we exclude their behavior, the average of the remaining transaction prices of *B* is close to the fully revealing equilibrium price. These two subjects' behavior induced the same pattern in period 5 of the same experimental session. The equilibrium price should be 50, but there are 31 trades with prices over 100. Out of these 31 transactions, 23 were bought by subject 9 (12 trades) and subject 10 (11 trades).

5.4. Real Time Transaction Data and the Direction of Information Transfer

The fact that the average transaction price in Market *A* tends to track the fully revealing equilibrium price indicates that the information held by the informed traders in that market leaks out to other market participants. Similarly, the fact that the average transaction prices in market *B* are highly correlated with those in market *A* suggests that information passes from market *A* to market *B*. Another indicator of the transference of information is from the market with the informed traders, *A*, to the market with no informed traders, *B*, is the time at which the first transaction in the neighborhood of the fully revealing equilibrium price occurs in market *A* relative to time the first transaction in market *B* falls into the same interval. We define *T* as the number of seconds left in a trading period when a transaction first occurs in the ε neighborhood of the fully revealing equilibrium price. In Figure 10 below these times are plotted for both markets in all sessions of treatment 3.

[Insert Figure 10 here]

In each graph in Figure 10, we plot the figures for T_A and T_B for each period and the value of T_A *minus* T_B. ε was chosen to be 5 for state *II* and 150 for state *I*.[7] If information flowed from *A* to *B* then most T_As should be greater than T_Bs. In fact, the lines called "time difference", which is simply (T_A - T_B), in Figure 16's graphs lie above the horizontal axis for most periods. The probabilities for T_A to be greater than T_B in the four sessions for treatment 3 are .73, .94, .82 and .59 respectively.

6. Conclusions

We implemented an experiment to study the effect of information use and transference on asset pricing and portfolio composition between legally separated stock markets. Like previous studies, we find that the information of informed traders gets reflected in the price of the asset in which those traders participate. We also find, when the location of those traders with inside information is known, participants in the market without insider information are often able to infer the right state and therefore reach the full-revealing equilibrium. The quality and clarity of signals sent out by the market with insider information directly affects the ability of the other market to infer the true state. Furthermore, when the location of the inside traders is known to be fixed, but is private information, the transference of information is delayed until there emerges a strong

[7] We have to increase the value of ε for state *I* because transaction prices for most periods never reach the equilibrium price level 300 for state *I*. If we narrow the interval, there won't be any transaction price that falls into the interval. We extended the intervals so that they are closer to the real average transaction prices.

correlation between the average transaction price in the market in which insiders participate and the true state.

These results provide theoretical support for the conjectures made by empirical studies on emerging capital markets that (some) domestic investors have better information than do foreign investors and that this difference in information induces the co-variance observed in price movements in assets that trade in legally separated markets.

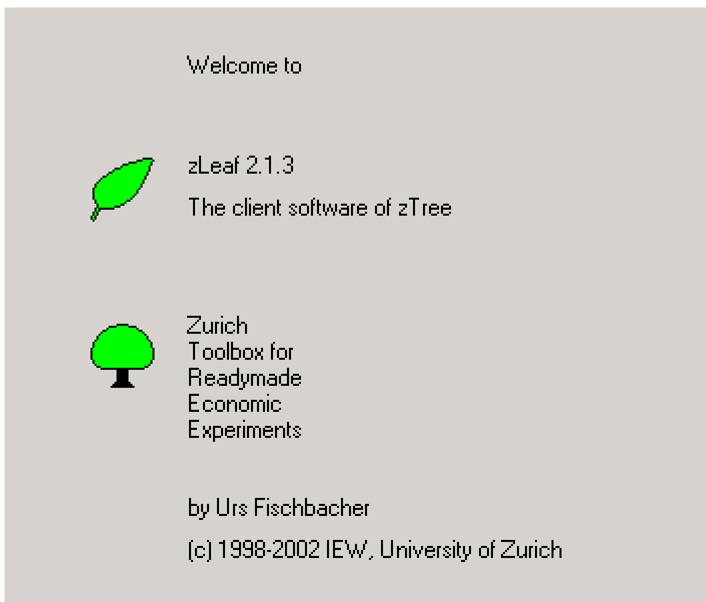
APPENDIX

1. Experimental Instructions (handed out to subjects prior to an experimental session):

INSTRUCTIONS

We are about to begin an asset market experiment where you can trade assets using experimental currency. The experiment is conducted in a computerized electronic market. We will describe to you how this market works and your interface with it.

Please raise your hand and talk to the experimenter if you don't see the following screen on your computer:



<u>Trading Screen:</u>

The left upper corner of the screen shows you the current trading period and the total number of trading periods we are going to play today. The right upper corner shows the remaining *seconds* of the *current* trading period. In today's experiment, each trading period is 5 minutes.

The bottom of the screen displays your subject ID and the current currency you have in your portfolio.

The rest of the screen is divided into two horizontal boxes, each for one specific asset.

There are two assets – A and B in today's experiment. On the left of each box, you will see the number of units of each asset in your portfolio. The above window indicates that you have 1 unit of asset B in your portfolio right now. (The next column is where you type to submit offers to sell asst B, right next to it is the column of existing offers submitted to the market to sell asset B. The middle column is the trading price for asset B. The next column on the right is the existing offers submitted to the market to buy asset B. The last column on the very right of the screen is where you work to submit offers to buy asset B.)

To place an offer to sell an asset, go to that asset's box and type the price you want to sell in the cell under the label "Offer to Sell Stock *x*". Click the button "Submit offer to Sell Stock *x*" to send your offer. **Please note** that you **won't be able to delete an offer** after you submit it, so make sure the price you typed in is correct before you hit the submit offer button. Your offer will be posted in the column of "Offers to Sell Stock *x*", which is to the right of the column where you submitted your offer. You can only trade *one unit at a time*, therefore there is no need to specify the quantity of assets in your offers. **Note** that once you submit an offer either to buy or sell an asset, *you are committed to that offer until either someone accepts the offer, or if no one accepts your offer, till the end of the current trading period.*

Follow the same steps to place an offer to buy an asset, the columns to submit buying offers and the columns to show to all the subjects the current submitted buying offers are laid symmetrically to the right of the box for each asset.

The offers to sell assets are displayed in the descending order of the submitted prices while the offers to buy assets are displayed in the ascending order of the submitted prices.

Accepting an offer results in a trade. If you would like to accept any of the offers (either to buy or sell an asset) submitted to the market, click the red button.

Note that accepting an offer from the column of "Offers to Sell Stock *x*" means that you are buying that stock from the subject who submitted the offer, while accepting an offer from the column of "Offers to Buy Stock *x*" means that you are selling that stock to the subject who submitted the offer at the specified price. After the transaction, the corresponding units of asset you traded and the currency left in your portfolio will be updated and the trading price will be posted in the middle column of "Trading Price for Asset *x*". Meanwhile, the offer will be eliminated from the column of existing offers.

There are a few restrictions regarding submitting offers and accepting offers to engage in trade.

First, every subject is only allowed to one of the two kinds of assets only. There are two groups of players: The first group is allowed to trade only asset A; the second group is allowed to trade only asset B. You can tell from the initial endowment of assets in your portfolio to see which group you belong to. If you are in the first group, you have units of asset A, but zero unit of asset B. Because of the division of two groups, you cannot post any offers or trade the other two assets of the other group. If you attempt to do so, you will get an error message informing you that you are not allowed to trade that particular asset. However, ***you can view information on the offers and transactions of all two assets*** from your screen regardless which group you belong to.

Second, you are also not allowed to trade with yourself, meaning that you cannot accept offers submitted by yourself. If you do so, an error message will appear.

Third, no short-sell is allowed, which means that if you don't have enough units of asset, you can't send out an offer to sell that many units. Similarly, you can't place a buy order if you don't have enough money left in your account. An error message will show up to inform you the situation.

Now let's take a 2 period trading practice.

<u>Summary Screen:</u>

At the end of each trading period, a summary screen will pop up.

On this screen, you will see the following information:

1) Trading currency held in your portfolio at the end of the current trading period.
2) Dividends for both assets A&B and number of units of each asset held in your portfolio for the current period.
3) Total dividends you earned from the assets held in the current trading period.
4) Interest earned on trading currency held in your portfolio for the current trading period.
5) Total income in francs in your portfolio for the current trading period.
6) Dollars earned for the current trading period.
7) Accumulative dollars earned so far in the experiment.

The experimenter will also announce a public report of the average transaction price for all assets A&B after the end of each trading period.

You will be asked to record some of the above information on a record sheet provided to you at the end of this trading period. After you are ready, click the "Please Wait" button to wait for all the other subjects to be ready to continue to the next trading period.

Now let's talk about the experiment you are about to participate in a few minutes.

In today's experiment, we will run 20 trading periods. Each period will last 5 minutes.

There are altogether two assets in our experiment: A & B which will generate dividends at the end of each trading period. The trading currency, money, will also generate interest returns.

Note that each asset only "lives" for one trading period. That is, your portfolio composition won't be carried over to the next trading period. In the beginning of each trading period, your endowment including both the assets and units of trading currency will return to the initial endowment. That is, each subject will have 10 units of assets (either A or B depending which group you are in) and 3500 units of trading currency to begin for every trading period. The only information will carry over is your accumulative earnings in dollar.

At the **end** of each trading period, there will be a dividend paid to each unit of the assets you have in your portfolio. **The dividend of each asset paid to you is determined by which state occurred at the end of the 3-minute trading period and by which type of trader you are.** There are two possible states: state I and state II. A random number drawn will determine which state will occur. The probability of state I (II) observed is 50%. There are two types of traders in each group. Half of the traders in each group are type X, while the other half is type Y. The dividend information is shown below:

Dividend for A&B	For type **X** (in francs)	for type **Y** (in francs)	Return on money (in francs)
$\vartheta_1 =$ 50% Probability of **state 1** observed.	300	150	1
$\vartheta_2 =$ 50% Probability of **state 2** observed.	25	50	1

<u>Note: Asset A and B always have the exact same dividend at the end of each trading period.</u>

Note: **The dividend is measured in francs, not money (the trading currency).**

The conversion from the game to your real dollar payment is like this:

Money (what you use to trade) and assets in your portfolio → *dividend and interest earned in francs* → *converted to dollars*

Your goal is to maximize the number of Dollars you can earn from each period!!! We will go over some example to see how this works.

In our experiment today, the conversion between points and dollars for each trading period is: **Dollars Earned = 0.00025* (francs)**

Treatment variables during the Experiment:

During the experiment, the experimenter may choose to introduce insider information to some subjects. The insider information is the private information given to selected subjects and it informs those subjects before the beginning of the next trading period about the true state that will be observed at the end of the next trading period. If some subjects receive such information, there will be a public announcement to all the subjects that some traders now begin to have insider information. The experimenter may also choose to tell all of the subjects the location (e.g., which group) of the subjects with insider information.

Summary of Important Points

Before we start our practice trading game, let me remind you the important points:

1) You will find from your screen that you can only participate in one of the two markets: either A or B. But you can always view information about both markets, including the one you can't participate.

2) Asset A and B always have the same dividend payoff for every trading period.

3) Don't forget the dividend information on assets and the one-franc return on trading currency:

Dividend for A&B	For type **X** (in francs)	for type **Y** (in francs)	Return on money (in francs)
$\vartheta_1 =$ 50% Probability of **state 1** observed.	300	150	1
$\vartheta_2 =$ 50% Probability of **state 2** observed.	25	50	1

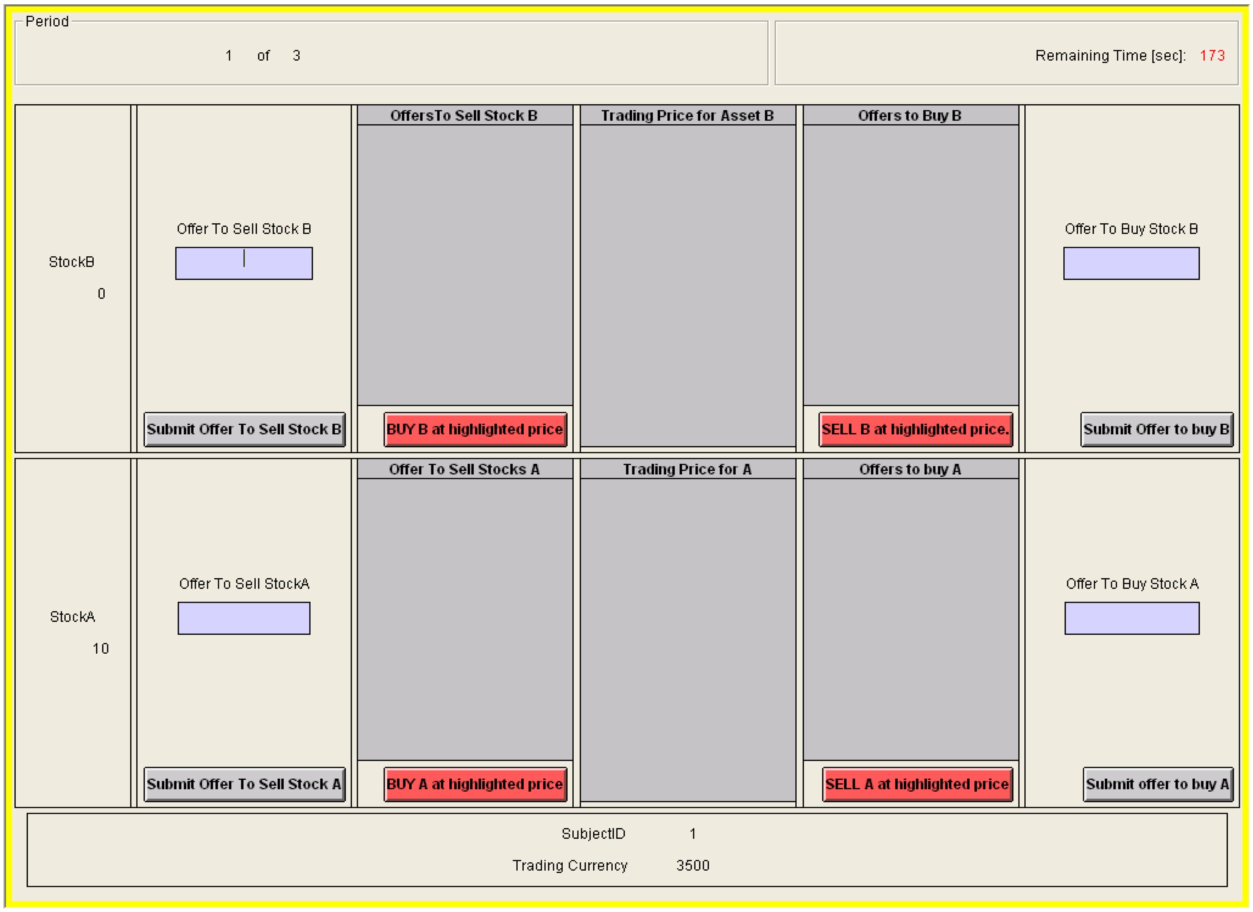
4) You are paid not by francs you earn from each trading period, but by the number of US dollars converted from the francs you earn.

5) Your portfolio composition of assets and trading currency won't carry over to the next trading period.

6) At the end of each 3-minute trading period, record your dividend francs, portfolio composition and the earnings in terms of dollars on the record sheet given to you.

During the experiment, the experimenter might choose to introduce insider information to certain subjects.

2. Trading screen that subjects see on their computer:



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Tables :

Table 1. Dividends and payoff information

	Dividends of *A* & *B* (in franc) for **TYPE *X***	Dividends of *A* & *B* (in franc) for **TYPE *Y***	Return on money (in franc) for both **TYPE *X*&*Y***
θ_1 = Probability of ***state I*** observed: .5	300	150	1
θ_2 = Probability of ***state II*** observed: .5	25	50	1

Table 2. Experimental sessions

Session Date	Treatment	Total # of Subjects in Both Groups	Subjects	# of Trading Period Implemented	Public Knowledge Distribution About Insiders		Equilibrium Model	Predicted Equilibrium	
					Existence of Insiders	Location of Insiders		Price	Stock Holding
Mar. 18, 2004	3	12	Inexperienced, Pitt Undergrad	15	Yes	Yes (in *A* market)	Full-Revealing	State *I*: 300 State *II*: 50	State *I*: *X* State *II*: *Y*
Mar. 19, 2004	1	12	Inexperienced, Pitt Undergrad	14	No	No	Prior Information	162.5	*X*
Mar. 25, 2004 Morning	2	12	Inexperienced, Pitt Undergrad	14	Yes	No	Full-Revealing	State *I*: 300 State *II*: 50	State *I*: *X* State *II*: *Y*
Mar. 25, 2004 Night	3	12	Inexperienced, Pitt Undergrad	17	Yes	Yes (in *A* market)	Full-Revealing	State *I*: 300 State *II*: 50	State *I*: *X* State *II*: *Y*
May. 26, 2004 Afternoon	3	12	Inexperienced, Pitt Undergrad	17	Yes	Yes (in *A* market)	Full-Revealing	State *I*: 300 State *II*: 50	State *I*: *X* State *II*: *Y*
May. 26, 2004 Night	3	12	Inexperienced, Pitt Undergrad	17	Yes	Yes (in *A* market)	Full-Revealing	State *I*: 300 State *II*: 50	State *I*: *X* State *II*: *Y*
May. 27, 2004	1	12	Inexperienced, Pitt Undergrad and Graduate	15	No	No	Prior Information	162.5	*X*

Figures :

Figure 1. Average transaction prices for Treatment 1 (Baseline Treatment)

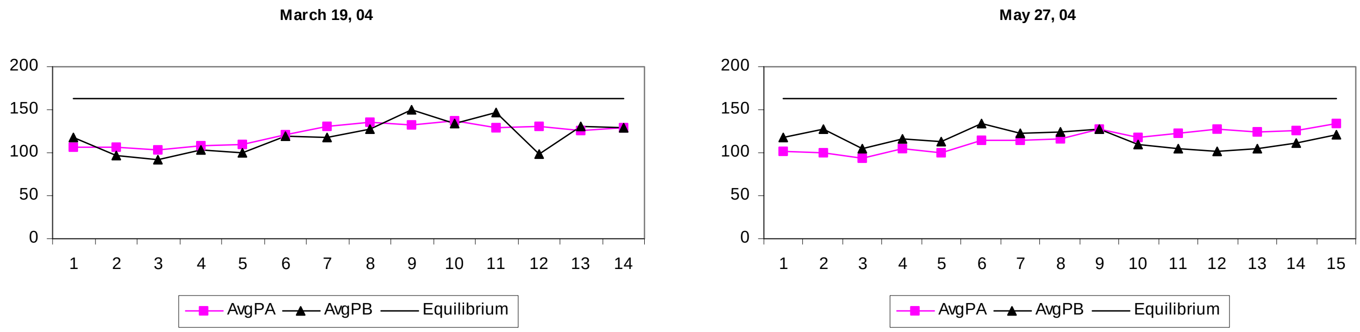


Figure 2. Stock holdings for Treatment 1

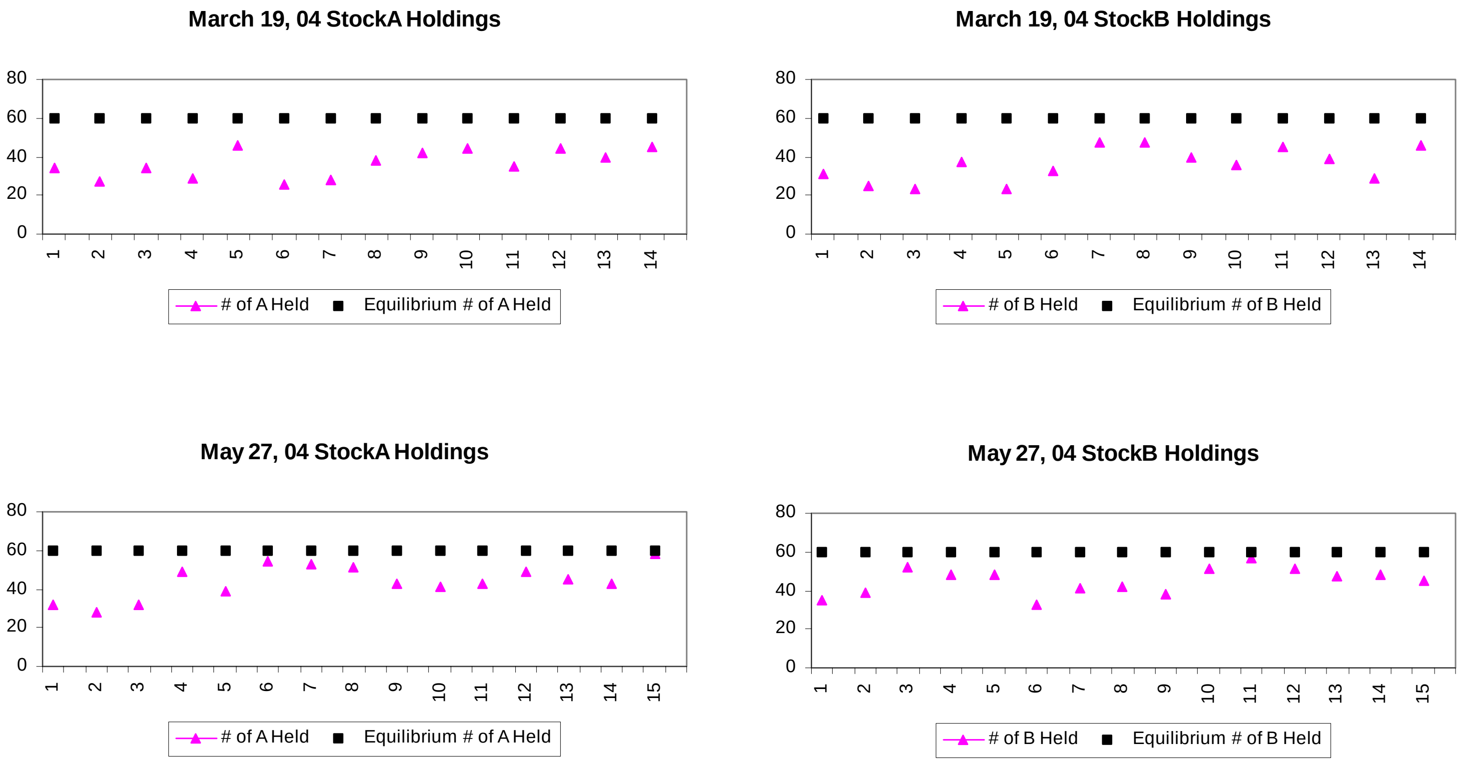


Figure 3. Average transaction prices for Treatment 3

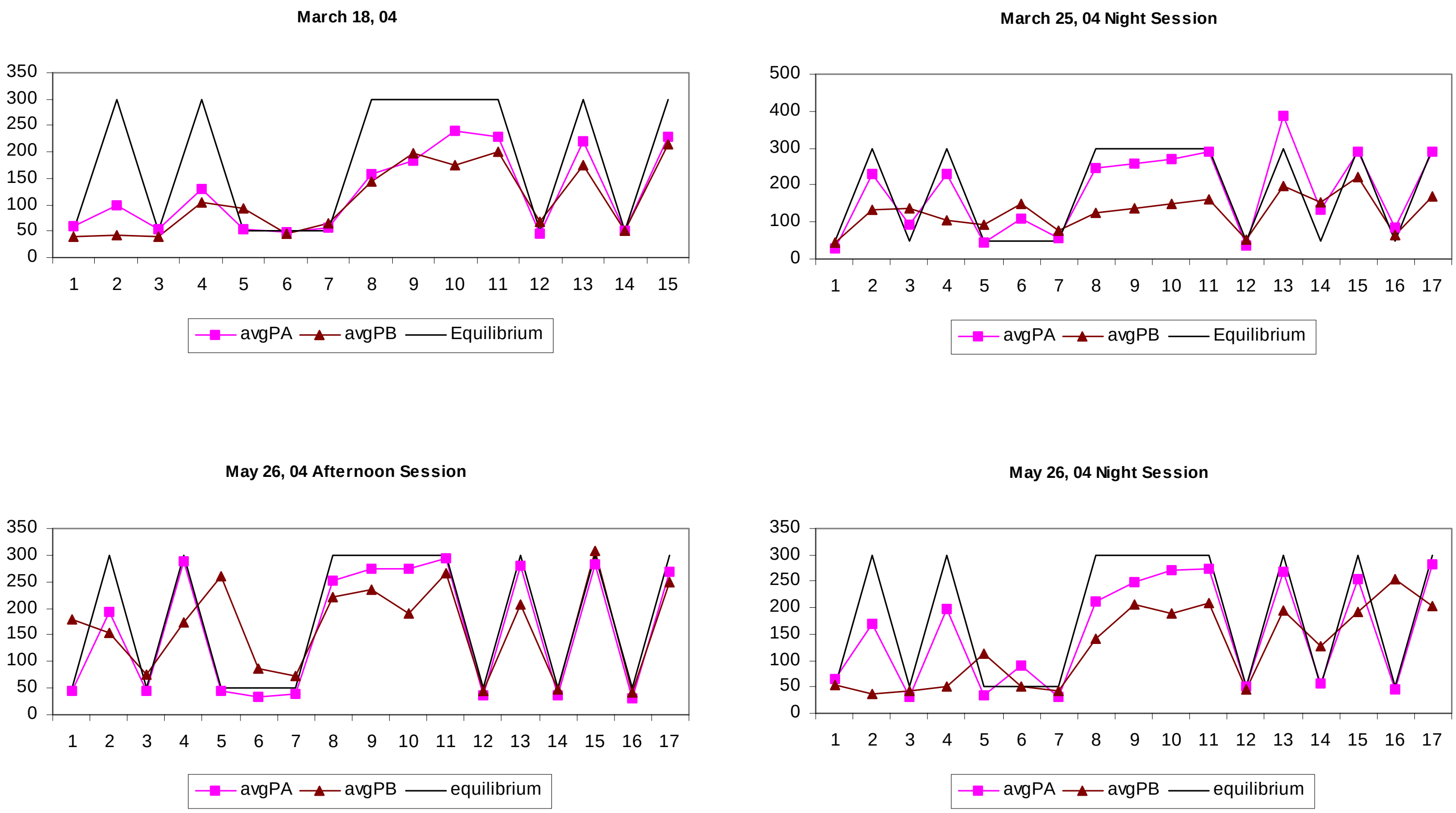


Figure 4. Stock holdings for Treatment 3

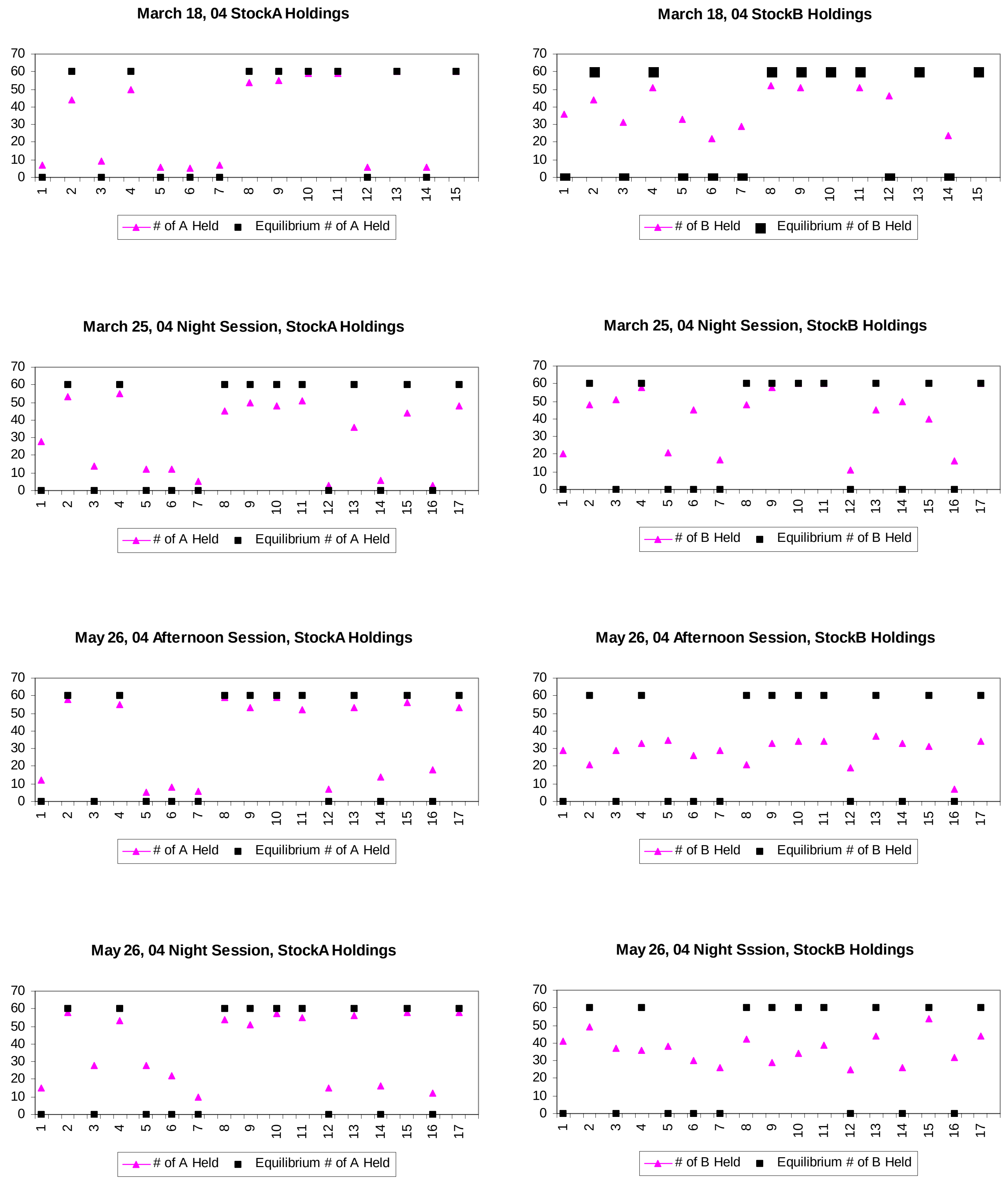


Figure 5. Average transaction prices for Treatment 2

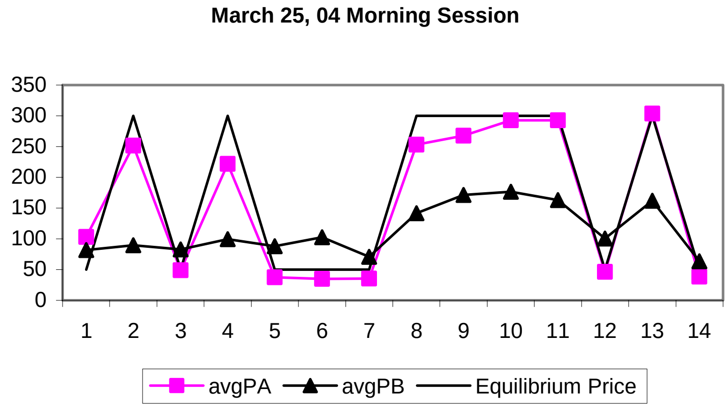
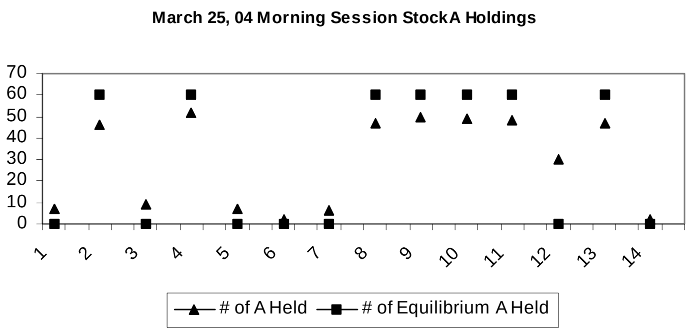


Figure 6. Stock holdings for Treatment 2



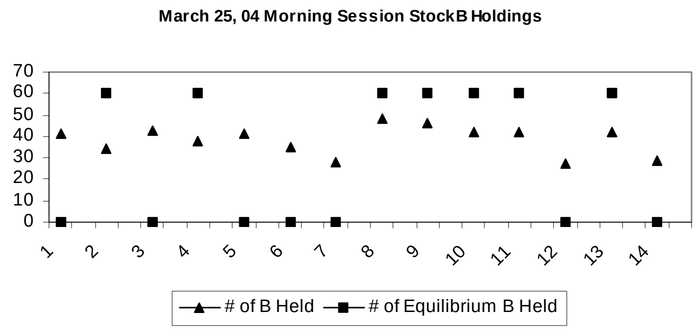


Figure 7. Informed traders successfully prevent information leaking until late in a trading period

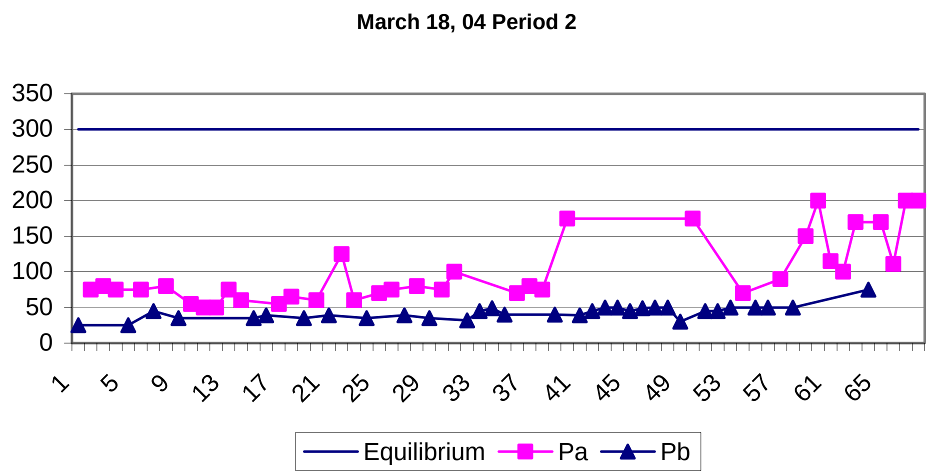


Figure 8. No clear trend in informed traders' market

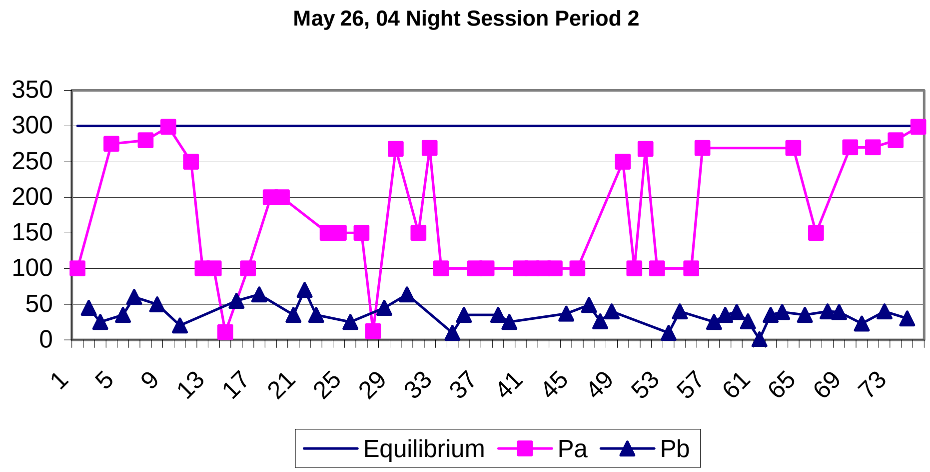
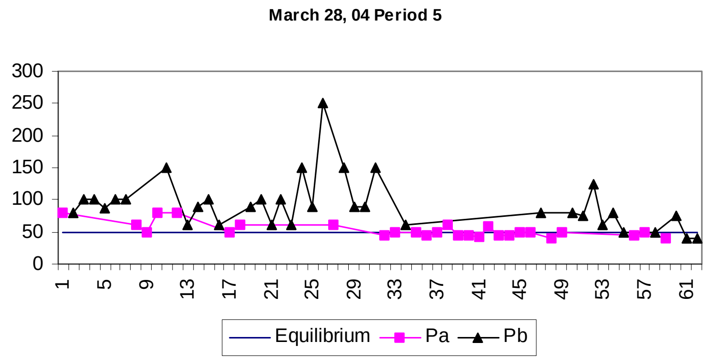


Figure 9. Scarce transactions in market *A* causing market *B* to fail to infer the correct state



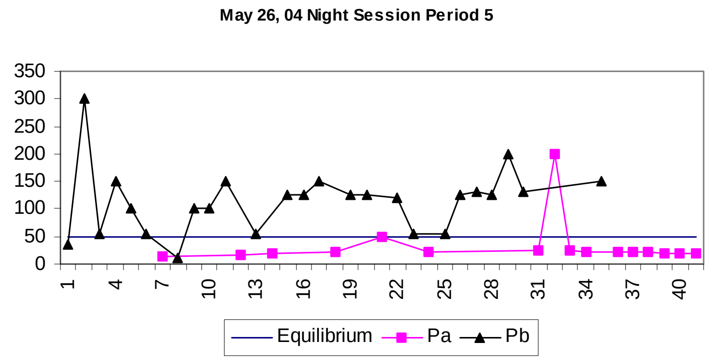


Figure 10. T_A and T_B for Treatment 3