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An Experimental Investigation of Asset Pricing in Segmented Markets

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This article reports the results of experimental asset markets in which participants trade two assets with distinct dividend claims. Some traders are able to transact in the markets for both assets; whereas, others can trade in only one market. When some are restricted from transacting in one market, the ineligible asset that cannot be traded by all commands a super risk premium. Without this premium, unrestricted investors would not hold all the available shares of the ineligible asset. In addition, we find that although unrestricted traders have the opportunity to remove all risk, few take advantage of this hedging opportunity. 1

JEL Classification: C92, G1

1. Introduction

In some markets, the trading of securities is restricted across investors. In this article we examine the effect of an investment barrier on asset pricing and portfolio composition using an experimental method. Whether the international capital market is integrated has received significant attention from researchers, yet as Solnick (1977) aptly points out, tests of integration and segmentation can be problematic. We specify a particular type of market imperfection and examine the resulting impact on market and investor behavior following Slonick's suggestion, as do Errunza and Losq (1985).

Many experimental economics studies have examined trading behavior and pricing in laboratory asset markets, including Plott and Sunder (1988) and Forsythe and Lundholm (1990). Typically the research investigates whether asset prices converge to theoretical predictions and efficiently reflect information. There are few experimental examinations of

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multi-market trading, particularly with cross-market trading restrictions.[1] Barriers to trade are not uncommon, particularly in emerging capital markets.[2]

Recently Qi and Ochs (2009) provide experimental evidence that prices in a market reflect information in another market, even if the markets are legally separated. In Qi and Ochs, the two markets are fully segmented in that traders can trade only in their own market; whereas, our asset markets are only partially segmented.[3] Another key design difference between our markets and those of Qi and Ochs is that the assets traded in each of their markets represented identical claims to the underlying flow of dividends. In contrast, the assets traded in our experimental markets represent different claims with distinct dividend payoffs.

In our experiment, some traders are able to transact in the markets for two assets; whereas, others can trade in only one market. Errunza and Losq (1985) refer to this structure as mild segmentation and provide theoretical predictions regarding pricing outcomes, including a "super" risk premium for assets with trading restrictions. Because some investors are prevented from holding the global market portfolio, the ineligible stock trades at a discount so that a risk premium is earned on this stock. If the stocks were traded freely, their prices would rise as expected return falls. Consistent with Errunza and Losq's predictions, the evidence indicates that easing of trading restrictions lowers a firm's cost of capital (Errunza and Miller 2000; Karolyi 2006).

The purpose of this article is to further examine how risk and the ability to diversify affect pricing and portfolio holdings across legally segmented markets. With our experimental design we are able to investigate predictions for market outcomes and trader decision making, while controlling for possible confounding influences.[4] This research provides new insight into the outcomes of legal restrictions on trading and investor behavior, an examination that cannot be conducted in naturally occurring markets. With an experimental method, we are able to control information and extraneous influences, while focusing on the questions of interest.[5]

The results indicate that legal restrictions can have very significant effects on asset pricing. In our experimental markets, the price of the asset that cannot be traded freely is lower than the price of the asset traded by all. Our markets provide additional insight into traders' decisions. The assets are designed so that unrestricted traders have the opportunity to perfectly hedge risk. Errunza and Losq show that as the correlation between the two assets falls, the effect of segmentation on pricing increases. Our assets are perfectly negatively correlated, and, thus, our

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[1] An exception is a recent working paper by Adams and Kluger (2007). In their experimental markets some participants were given trading privileges in a subset of market periods. Thus, their traders are restricted regarding when they can transact in the market. Their experimental design is distinct from ours because their goal is to provide insight into the pattern of trade across time; whereas, ours is to examine market behavior across legally separated markets.

[2] China, the Philippines, Singapore, Thailand, Taiwan, and several other emerging stock markets have imposed restrictions on foreign share ownership at various times in history. But trading restrictions are not limited to emerging markets. For example, the Restrictions Act of 1939 significantly limited foreign shareholdings in Finnish companies.

[3] Qi and Och's markets are analogous to markets for Chinese stocks in which Chinese citizens and foreigners trade in legally separated share markets.

[4] While Errunza and Losq's model provides a basis for the development of hypotheses, we do not consider our investigation a direct test of Errunza and Losq's predictions because there are important differences between their theoretical model and our experimental market. For example, Errunza and Losq permit short selling. In addition, Errunza and Losq assume that real returns are normally distributed and that the expected utility of each investor is a function of the expected payoffs and variance of real returns. In our simple environment we do not need to specify a form for expected utility. Though there are differences between Errunza and Losq's model and our experimental design, their model inspired the specific segmentation phenomenon we examine.

[5] In our experimental design there is no information asymmetry, so divergent information cannot play a role in pricing.

Table 1. Experimental Structure

Panel A: Experimental design

Session Number[1]	Treatment	Trader Numbers	Assets Traded	Endowment Asset 1	Endowment Asset 2	Endowment Cash
A1,A2,A3, A4, A5, A6, A7	A	1–3	1	3	0	1350
		4–6	1 and 2	0	6	900
		7–9	1 and 2	6	3	450
B1, B2, B3, B4	B	1–3	1	5	0	1050
		4–6	1 and 2	4	4	600
		7–9	1 and 2	0	5	1050
Total assets and cash in each market				27	27	8100

Panel B: Distribution of dividends

Asset Dividend Distributions			Expected Value of Dividends
State	I	II	150
Probability	0.50	0.50	
Asset 1's dividends	5	295	
Asset 2's dividends	295	5	

[1] All markets include 15 trading periods and 9 traders.

design provides a strong incentive for risk-averse traders to balance their holdings—if they can. Although a minority of unrestricted traders takes advantage of this opportunity, most do not.

The remainder of the article is organized as follows. Section 2 describes the experimental design. Section 3 motivates and defines the hypotheses to be tested. The following section presents the experimental results. Section 5 concludes.

2. Experimental Method

The asset market experiments were conducted in the EXperimental Economics CENter (EXCEN) at the Andrew Young School of Policy Studies at Georgia State University. We report on 11 market sessions in two treatments.[6] The experimental design, summarized in panel A of Table 1, includes markets with two traded assets. Treatments A and B differ only in terms of traders' initial endowments. The two endowment structures allow us to assess whether more or less symmetric buying and selling pressure impact pricing or asset holdings. The two endowment structures are necessary to isolate the effect of partially segmented markets and ensure that observations are not the result of asymmetric buying pressure. Asset 1 is eligible for trade by all nine participants, and asset 2 is not available, or ineligible, for three of the nine participants.[7] Traders 1–3 can trade only asset 1, and traders 4–9 can trade both assets.

[6] We ran three pre-tests to refine the experimental procedures. In particular, we added to the instruction period to ensure participant understanding. Because changes were made to the parameters and instructions, we do not include the pre-tests in our analysis. In addition, we ran a third treatment in which each asset was ineligible to a group of three traders. This treatment was included to examine whether demand effects impacted pricing, because in the treatments reported in this article there are different numbers of participants trading each asset. The results of the third treatment are not included here because they provided no evidence that a demand effect could explain observed pricing or holdings behavior.

[7] Assets 1 and 2 are referred to as "asset E" and "asset I" in the experimental instructions.

Nine traders participated in each session. All trading was in francs, the experimental currency, which was converted into dollars at a rate of 1 franc = \$0.0012 so that 1000 francs = \$1.20. Subjects were undergraduate and graduate students with a variety of majors. All were inexperienced in that none had participated in an earlier session of similar design. Students earned from \$16.25 to \$64.50 for their participation, with an average payout of \$41.13.[8]

Each market session consisted of 15 three-minute periods, organized as computerized double auction markets using the z-Tree (Zurich Toolbox for Readymade Economic Experiments) software (Fischbacher 2007).[9] With z-Tree subjects can transact in real time over a number of market periods. They can post bids and asks and also act as price takers. For all sessions, traders were permitted to transact each asset one unit at a time. Although participants may have been restricted from trading in one of the markets, they could observe trading activity in both markets on their computer screens. 2

On arrival subjects received a set of instructions, and one of the experimenters did an extensive recap while addressing all procedural and technical questions.[10] The sessions
C1 generally required 2 ½ hours to complete. At the beginning of each trading period, participants were endowed with shares of the securities and cash, though some asset endowments were set to zero, as Panel A of Table 1 indicates. Subjects were endowed with cash at the beginning of each period to finance trade, and the amount of cash was chosen so that all participants had portfolios of equal expected value. At period end, each asset paid a dividend that was randomly determined using the distributions reported in panel B of Table 1, with dividend draws being intertemporally independent. Note that the expected dividend for both assets is identical at 150 francs per period. At the end of a period, the observed state of nature was publicly announced, and asset holders received their dividends. The experimenter also reported the average transaction prices of each asset at the end of each trading period. Each asset had a one period life. Subsequent trading periods began anew with constant endowments for each trader across all 15 trading periods.

At the end of each period the final cash balance was (privately) displayed on a subject's computer screen. After the 15 trading periods were finished, participants completed a post-experiment questionnaire that included demographic questions as well as reactions to the experiment. To motivate them to respond carefully, they were given additional compensation of \$4 for completing the questionnaire. Thereupon the experimenters paid participants privately in cash.

3. Hypothesis Development

As described in the previous section, our experimental design restricts some participants from trading in a stock. Figure 1 illustrates the design. The restricted investor can hold only the eligible security (asset 1); whereas, the unrestricted investor can hold both the eligible and

[8] Participants' total compensation included a \$4 bonus for being on time and \$4 for completion of the post-experiment questionnaire. All of the 90 participants received the additional compensation of \$8.

[9] This software is provided to experimental researchers by the University of Zurich, Institute for Empirical Research in Economics. See http://www.iew.unizh.ch/ztree/index.php.

[10] The instructions are included in the Appendix.

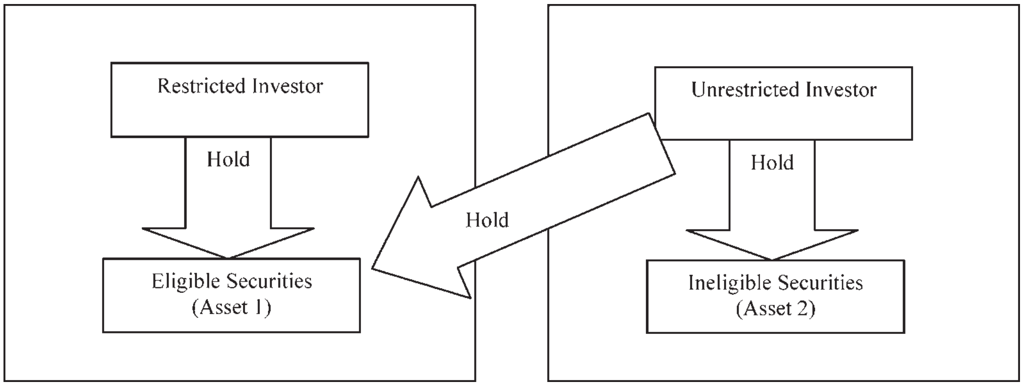


Figure 1. Trading Restrictions

ineligible securities (assets 1 and 2). The two treatments differ only in regard to traders' initial endowments.

Errunza and Losq (1985) present a model of asset pricing in a mildly segmented world capital market. In their segmented markets, investors have unequal access to some markets. As in our design, the markets are not completely segmented because some traders can hold all securities (the unrestricted investors), and others can hold only eligible securities (the restricted investors). Errunza and Losq predict that in a world with mildly segmented capital markets and risk-averse investors, the ineligible assets will command a "super" risk premium. Because some investors are prevented from holding the ineligible assets, they cannot hold the global market portfolio, and a higher risk premium for ineligible stocks results. Without a super risk premium, the unrestricted investors would not hold the ineligible assets, and these assets would be in excess supply. The super risk premium motivates the unrestricted investors to hold the excess shares of the ineligible asset.

In our markets the payoffs for the two assets are perfectly negatively correlated. As we see in panel B of Table 1, when one asset has a high payoff, the other has a low payoff. Errunza and Losq (1985) show that the effect of mild segmentation on pricing is larger when the correlation between the two segments is lower.[11] A compelling aspect of our design is the potential that some investors have to diversify away all risk. Notice that because of the perfect negative correlation between assets, the unrestricted investor can eliminate all risk by holding an equal number of each asset. The unrestricted investor will always earn the expected value of the dividend payouts as long as asset 1 and asset 2 are held in exact proportion to one another. Because the restricted investor cannot hold the ineligible asset, he cannot eliminate risk. Notice that this implies that even a risk-averse unrestricted investor might actually pay *more than the expected value* for a unit of either asset to match a unit of the other asset.

[11] Errunza and Losq also show that the effect of segmentation increases when the unrestricted are more risk averse. At this time, there is no well-accepted experimental method to control for risk attitudes. Thus, we are implicitly assuming that subjects' risk preferences are similar across markets, which is a reasonable assumption given that participants were recruited from the same subject pool. Holt and Laury (2002) report that the majority of their participants are risk averse. In their low-payoff treatment, two-thirds of the participants make choices that indicate risk aversion. In their high-payoff treatment, 80% of their subjects exhibit risk aversion. Further support for our assumption comes from the similar results across the 11 experimental markets, as reported later in the article. Finally, we do not allow subjects to short sell assets they do not own, which limits the available strategies.

In our experiment, as in Errunza and Losq's world, the restricted investors are unable to hold asset 2 and, thus, cannot diversify. If there is no super risk premium, the ineligible asset is in excess supply. If the restricted investors are risk averse, the value of the eligible asset to them is less than its expected value (150 francs). In our experiment there are equal numbers of asset 1 and asset 2. Thus, at the margin, if the restricted investors are willing to sell all shares of the eligible asset, all shares of both assets should be held by the unrestricted investors who will pay at least the expected value for both stocks. This leads to our first set of hypotheses, stated in the null and alternative forms, where the null hypothesis reflects the case in which segmentation has no effect:

Hypothesis 1. The prices of the ineligible and eligible securities will equal or exceed expected values.

Hypothesis 1A. The price of the ineligible security will be less than expected value because of a super risk premium.

In addition, we examine Errunza and Losq's prediction that the ineligible security will command a super risk premium relative to the eligible security, which gives our second set of hypotheses, stated in the null and alternative forms:

Hypothesis 2. The prices of the ineligible and eligible securities will be equal.

Hypothesis 2A. If traders are risk averse, the ineligible security commands a risk premium, and its price is lower than the price of the eligible security.

We can also examine the allocational efficiency of our markets. Because the unrestricted traders, at the margin, value the eligible securities more than the restricted traders, and each market includes equal numbers of assets 1 and 2, all shares of the eligible asset should be held by unrestricted traders. This leads to our third set of hypotheses, stated in the null and alternative forms:

Hypothesis 3. The unrestricted investors do not hold all of the eligible shares.

Hypothesis 3A. The unrestricted investors hold all shares of the eligible and ineligible assets.

Another aspect of allocational efficiency is the proportion of eligible and ineligible shares held by the unrestricted investors. Recall that because of the dividend payout structure, the unrestricted investors should hold the shares in equal numbers if they are risk averse. This gives our fourth set of hypotheses, stated in the null and alternative forms:

Hypothesis 4. The unrestricted investors hold a smaller number of eligible shares than ineligible shares.

Hypothesis 4A. The unrestricted investors hold eligible and ineligible assets in equal numbers.

After consideration of descriptive data, we turn to tests of each hypothesis.

4. Market Behavior

In this section, we provide descriptive data to assess price behavior. For every market we plot transactions prices for each asset across periods. We also provide descriptive data on pricing and allocational efficiencies in our markets and conduct tests to determine whether there are significant differences in outcomes across the assets.

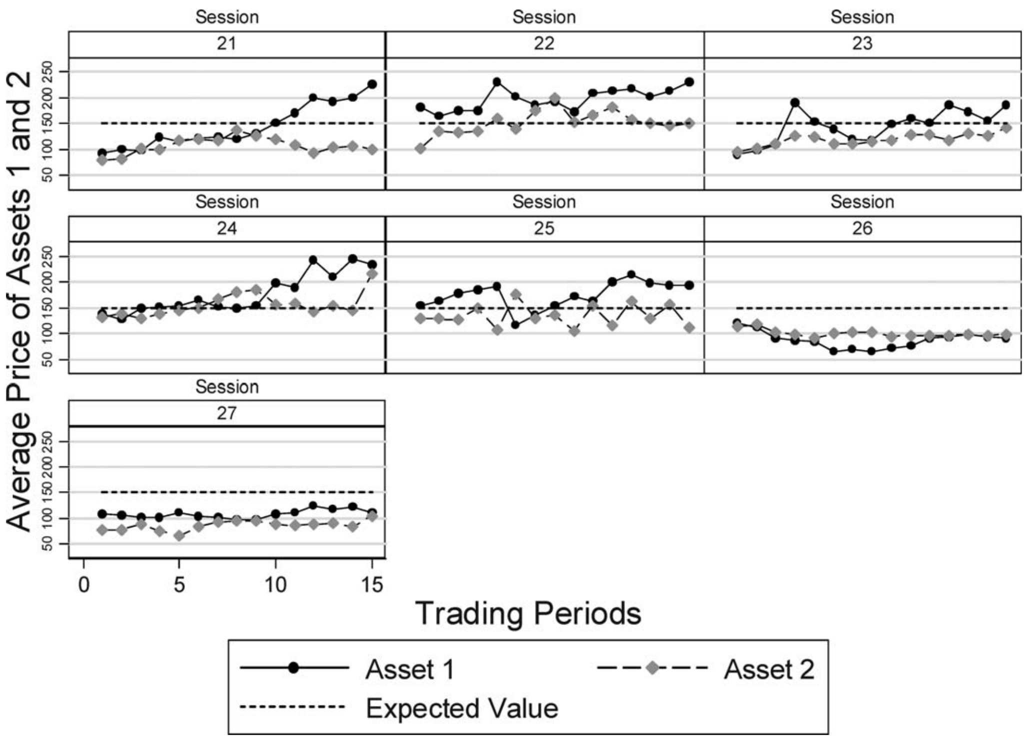


Figure 2. Mean Transaction Prices for Treatment A

Figures 2 and 3 show the average transaction price each period for assets 1 and 2 in treatments A and B.[12] Recall that asset 1 was eligible for trade by all participants; whereas, some participants were restricted from trading asset 2. Prices do not appear to consistently settle down to the expected value of 150 francs for either asset, and the price of the eligible asset 1 is generally higher than that of the ineligible asset 2, particularly in the latter half of trading.

Panel A of Table 2 reports summary statistics, including the mean of all transaction prices across all 15 trading periods and the mean of all the transaction prices in the last three and five periods. In the table and subsequent analysis we combined the data for treatments A and B, as the two treatments reveal consistent behavior. Inferences are unchanged for either treatment considered in isolation.[13] The observed transaction prices for the eligible asset 1 are consistently higher than for the ineligible asset 2 regardless of whether we consider all prices or prices in the final periods.

Table 2 presents formal tests of our first two hypotheses, which relate to valuation in the markets. The first alternative hypothesis posits that the price of the ineligible asset will fall below the expected payoff of 150 francs. The results reported in panel A of Table 2 are consistent regardless of whether we use the mean transaction price over all transactions or the prices in the last three and five periods. For the eligible asset, we cannot reject the null hypothesis that the asset's price is greater than or equal to its expected value. For the ineligible

[12] The time series are similar for the average of the last three transactions prices per period.

[13] Recall that treatments A and B differ only in terms of traders' initial endowments. All analyses reported subsequently in the article were conducted using data from each treatment separately. We found no evidence that asymmetric buying or selling pressure resulting from the trader endowments impacted pricing or asset holdings.

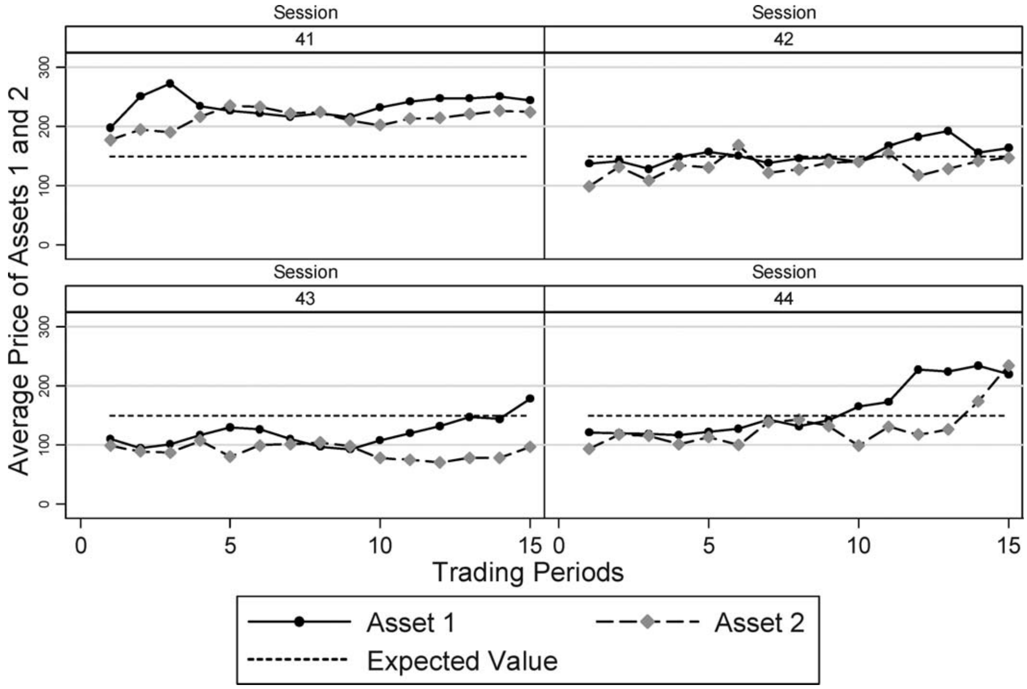


Figure 3. Mean Transaction Prices for Treatment B

Table 2. Tests of Price Predictions

Panel A of the table reports the mean of all transaction prices across all 15 trading periods and the mean of all the transaction prices in the last three and five periods. Also reported in panel A are the results of *t*-tests of Hypothesis 1, which conjectures that the prices of the eligible and ineligible assets equal or exceed the expected value of 150 francs. In panel B the table reports tests of Hypothesis 2, which conjectures that the prices of the eligible and ineligible assets are equal. Statistics are reported for three Wilcoxon signed-rank tests, that is, all transaction prices for all periods, all transaction prices for the last three periods, and all transaction prices for the last five periods, respectively. A binomial test and GMM test of equality are also reported. In parentheses below each statistic we report *p* values for tests of the null hypotheses. All *p* values are for one-tailed tests.

Panel A: Transaction prices and *t*-tests of whether prices equal or exceed expected values

	Asset 1 (Eligible)	Asset 2 (Ineligible)
Mean transaction price	154.86 (0.90)	129.20 (0.00)***
Mean of the transaction prices in the last 3 periods	184.73 (0.99)	136.99 (0.054)*
Mean of the transaction prices in the last 5 periods	181.68 (1.00)	133.54 (0.00)**

Panel B: Tests of whether the prices of the eligible and ineligible assets are equal

Session average prices *z*-score	8.45 (0.00)***
Session average prices *z*-score for the last 3 periods	8.45 (0.00)***
Session average prices *z*-score for the last 5 periods	4.80 (0.00)***
Binomial	6.24 (0.03)**
GMM	26.44 (0.00)***

***, **, and * indicate rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.

asset, however, the price is significantly less than its expected value ($p < 0.10$). As predicted by Errunza and Losq, the ineligible asset 2 seems to command a super risk premium.

Panel B of Table 2 reports tests of whether the two assets are valued equally in the market. This hypothesis is strongly rejected. The price of the eligible asset that all participants can trade is significantly larger than the price of the ineligible asset that some are not permitted to trade. Again, the results are consistent regardless of whether we use the mean of all transactions, last three, or last five periods' prices. Overall, our results provide strong support for the notion that the ineligible asset commands a super risk premium.

We conduct additional analysis to examine the robustness of our conclusions. Because participants' decisions across periods within a market may be correlated, the independence assumption of the Wilcoxon and *t*-tests are likely violated. To alleviate misspecification concerns, we perform additional tests of our relative price prediction. First, we consider a binomial test comparing average prices for the two assets. Under the null hypothesis that investors value the two assets the same, the average price difference should be zero, and the probability that we observe one price above the other is 0.50. We define a binomial variable as equal to one when the average price of asset 1 in the last period of a market is larger than the price of asset 2 (and equal to zero otherwise). Because this test uses only information from the final trading period, we do not have the lack of independence concern. The binomial variable equals one in 9 of 11 sessions, which corresponds to a *p* value of 0.033 and suggests that the null hypothesis should be rejected.[14] As with the Wilcoxon and *t*-tests, we find that the price of the eligible asset is significantly larger, supporting our conjecture regarding a super risk premium for the ineligible asset.

Because a great deal of information is lost, the binomial test is a useful, but crude, method to assess outcomes. To more fully consider all information from each period we also use a robust generalized method of moments (GMM) estimator of the price difference between the two assets, which treats the correlation and heteroskedasticity in the data. Because the two assets trade at different times, for each trade we compute the difference between the current price for one asset and the price at which the other asset traded last. We then estimate a GMM regression of the price difference on a constant, with a constant as the only instrument. The estimated constant parameter in the regression is just the sample average of the price difference. The significance of the price difference across all sessions is tested using standard errors computed using the Newey and West (1987) estimator with the Andrews (1991) automatic bandwidth selection, which is robust to autocorrelation and heteroskedasticity. The GMM regression is specified as

$$\mathrm{Pr}_t^E - \mathrm{Pr}_t^I = c + \varepsilon_t, \tag{1}$$

where Pr_t^E is the price of the eligible asset at time *t*, Pr_t^I is the price of the ineligible asset that was last traded at or prior to the trade of the eligible asset at time *t*, *c* is a constant, and ε_t is the possibly autocorrelated and heteroskedastic error term. This test, reported in panel B of Table 2, gives an average price difference of 26.44 ($p < 0.0001$). This result is particularly strong given that prices tend to stabilize toward the conclusion of trading.

Next we consider two null hypotheses relating to the allocational efficiency of the markets. The alternative form of Hypothesis 3 posits that the unrestricted investors hold all shares of

[14] We also define a second binomial variable as equal to one when the average price of asset 1 in the last three trades in the last period of the session is higher (and equal to zero otherwise) The second binomial variable is equal to one in 7 out of 11 sessions, but gives an inconclusive test (*p* value = 0.274). Given the lack of power of the binomial test, it is perhaps not surprising that the statistic is insignificant.

Table 3. Allocational Efficiency
Panel A of the table reports the average holdings of the eligible asset by restricted and unrestricted traders in early (first 5) and late (last 5) trading periods. Panel B of the table reports asset imbalances in unrestricted traders' final stock positions calculated as |#Asset 1 − #Asset 2|. For each value of the imbalance, the table reports the percentage of period-ending trader imbalances.

Panel A: Distribution in holdings of the eligible asset in early and late trading periods

	Restricted Traders	Unrestricted Traders
Early periods	3.95	2.53
Late periods	3.29	2.85
t-test (*p* value)	0.08*	0.12

Panel B: Unrestricted traders' asset imbalances

	Final Position (%)
No shares held	7.7
|#Asset 1 − #Asset 2| = 0	10.1
|#Asset 1 − #Asset 2| = 1	18.4
|#Asset 1 − #Asset 2| = 2	12.0
|#Asset 1 − #Asset 2| = 3	10.2
|#Asset 1 − #Asset 2| > 3	41.6

***, **, and * indicate rejection of the null hypothesis at 1%, 5%, and 10% significance levels, respectively.

both assets. Because the unrestricted investors already hold all shares of the ineligible asset 2, we test whether they hold all shares of the eligible asset. Of the 27 shares of asset 1 in the market each period, the unrestricted participants hold, on average, 16.15 units. Though the unrestricted hold a majority of the shares of the eligible security, we reject the hypotheses that they hold them all at $p < 0.001$. Panel A of Table 3 indicates the average holdings of the eligible asset by restricted and unrestricted traders in early (first 5) and late (last 5) trading periods. Although the average end-of-period holding shifts slightly toward greater holdings of the eligible stock by the unrestricted, the change is small and not highly significant.[15]

To provide further insight into allocational efficiencies, we examine whether unrestricted investors attempt to hedge by holding assets 1 and 2 in equal numbers. Panel B of Table 3 reports asset imbalances in unrestricted traders' final stock positions. We compute asset imbalance as |#Asset 1 − #Asset 2|, with panel B reporting data for the 11 markets. With the initial endowments, the average imbalance for the unrestricted investors is 4.5 shares, and the final imbalance is 3.59. For each value of the imbalance, the table reports the percentage of period-ending trader imbalances. We observe that some traders attempt to balance their holdings of the two assets so that their portfolio is fully hedged. However, over 50% of end-of-period holdings have an imbalance of three or more shares. The alternative form of the fourth research hypothesis conjectures that unrestricted investors hold eligible and ineligible shares in equal proportion. The average holdings imbalance of 3.59 is statistically different from zero at $p < 0.01$.[16]

[15] We do not report holdings of the ineligible asset as, by definition, the unrestricted always hold all shares of this asset. Restricted investors may continue to hold the eligible shares due to the effect of a status quo bias or an endowment effect, in which case they highly value the eligible shares because these are the only shares they can hold. Future research on this issue may prove insightful.

[16] It is possible that participants conclude that the dividend risk is small, particularly in the early trading periods, because the variance of returns is small over 15 trading periods. Future research may investigate whether this view leads to trading imbalances.

5. Discussion and Concluding Remarks

This article reports the results of experimental asset markets in which market participants traded two assets. When some traders are restricted from participating in one market while others are free to trade in both, the ineligible asset commands a super risk premium. Without this risk premium, unrestricted investors would not want to hold all the available shares of the ineligible asset. In addition, we find that the majority unrestricted traders do not take advantage of the opportunity to eliminate risk. Because the payoffs of our assets are perfectly negatively correlated, risk-averse traders should hold the assets in equal proportion.

Our results have important implications for international policy. Regulators should carefully consider the impact of imposing market trading restrictions. Such restrictions can have a negative impact on firms that are trying to maximize shareholder value. A super risk premium increases the cost of capital to the firm. If the shares were freely traded in the international economy, stock prices may rise.

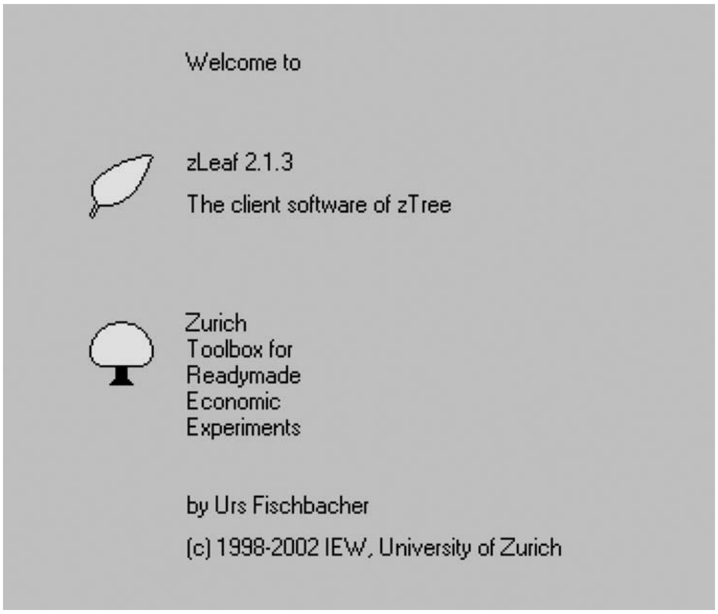
Appendix: Experimental Instructions

The computerized double asset markets were conducted using z-Tree. The participants were given the following written instructions.

Instructions

We are about to begin an asset market experiment where you can trade stocks 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 let the experimenter know if you don't see the following screen on your computer:



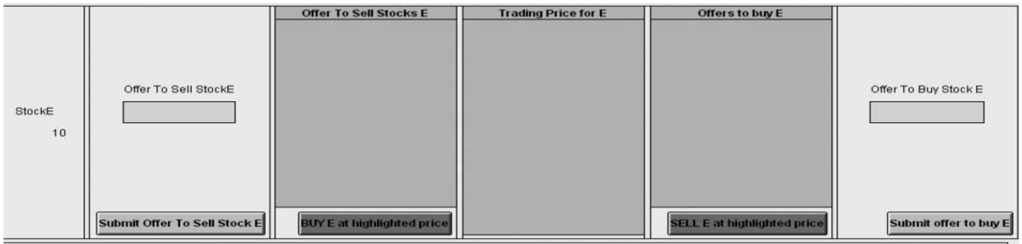
Please follow along as the experimenter reads these instructions aloud. Feel free to ask questions at any time. We will practice trading on the computer before the actual market begins.

Trading Screen

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 3 minutes.

The bottom of the screen displays your subject ID and the money you have in your portfolio. We will call the experimental currency francs.

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



There are two assets (stock E and stock I) in today's experiment. On the left of each box, you will see the number of units of each stock in your portfolio. The above window indicates that you have 10 units of stock E in your portfolio right now. The next column is where you submit offers to sell stock E; right next to it is the column of existing offers submitted to the market to sell stock E. The middle column is the trading price for stock E. The next column on the right shows existing offers submitted to the market to buy stock E. The last column on the very right of the screen is where you submit offers to buy stock E.

To Sell or Buy a Stock

You **won't be able to delete or change an offer** to sell or buy after you submit it, so make sure the price you type is correct before you hit the submit offer button. Also remember that you can only trade *one unit at a time,* therefore there is no need to specify the quantity you wish to trade.

To place an offer to sell a stock, 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. 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. Once you submit an offer either to buy or sell a stock, *you are committed to that offer until someone accepts the offer, or if no one accepts your offer, until the end of the current trading period.*

Follow the same steps to place an offer to buy a stock. The column to submit buying offers and the column showing the current submitted buying offers are laid symmetrically to the right of the box for each stock. The offers are displayed in descending order using submitted prices.

Accepting an offer results in a trade. If you would like to accept any of the offers (either to buy or sell a stock) submitted to the market, click the red "Accept" 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 the stock you traded and the francs left in your portfolio will be updated, and the trading price will be posted in the middle column of "Trading Price for *x*." Meanwhile, the offer will be eliminated from the column of existing offers.

Notice that there are 2 ways to sell a stock. First, an offer to sell you have submitted may be accepted by another trader. Second, you can accept another trader's offer to buy. Similarly, there are 2 ways to buy a stock. First, an offer to buy you have submitted may be accepted by another trader. Second, you can accept another trader's offer to sell.

There are a few restrictions regarding submitting and accepting offers when trading. They are summarized as follows:

In today's experiment, some of you will be able to trade both stock E and stock I (subjects 4–9), while others are only allowed to trade E (subjects 1–3). However, **you can view information on the offers and transactions of both stocks** on your screen regardless of your group membership.

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-selling is allowed, which means that if you don't have a unit of a stock, you can't send out an offer to sell that stock. Similarly, you can't place a buy order if you don't have enough money left in your account. An error message will inform you of the situation.

Let's start a practice trading period.

Summary Screen

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

On this screen, you will see the following information:

(1) Francs held in your portfolio at the end of the current trading period.
(2) Dividends for each stock and number of units of each stock held in your portfolio for the current period.
(3) Total dividends you earned from the stocks held in the current trading period.
(4) Total income in francs for the current trading period.
(5) Dollars earned for the current trading period.
(6) Cumulative dollars earned so far in the experiment.

The experimenter will publicly announce the average transaction price for each stock at the end of each trading period.

You will be asked to record some of the above information on a record sheet included in the folder with these instructions. 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!

Today's experiment will include 15 trading periods. Each period lasts 3 minutes. There are two stocks in our experiment: E and I, which generate dividends at the end of each trading period. The trading currency is francs.

At the **end** of each trading period, a dividend is paid on each unit of the stocks you have in your portfolio. The dividend for each stock is determined by which state occurred at the end of the 3-minute trading period. There are two possible states, state I and state II. A random number draw determines the state. The probability distributions of the realization of each state in the experiment and the dividend payoff corresponding to each state are described in the following table:

	Dividend of E (in Francs)	Dividend of I (in Francs)
State I (probability 0.50)	5	295
State II (probability 0.50)	295	5

Notice that the expected payoff for each stock is 150 francs because half the time you will earn 5 francs and the other half of the time you will earn 295 francs. Remember that each stock lives only 1 period so that at the beginning of each trading period your holdings begin again at your initial endowment.

To convert your earnings into dollars, add the francs remaining at period end to dividend earnings and multiply by 0.0012. Thus, 1000 francs in total would be equal to $1.20.

How Do You Earn Your Payoff?

Remember that your cash payoff is determined by the dividends you earned on stocks ***and*** *the francs in your portfolio at the end of each trading period.*

Based on the above table that determines the occurrence of the state, *each unit of stock E or I will yield 150 francs on average per trading period.* For example, a portfolio that only contains 150 francs will yield 150 francs per period no matter which state occurs. However, a portfolio that contains *only* one unit of stock E will do well half of the time, but poorly the other half of the time, and, on average, you expect 150 francs per period.

Summary of Important Points

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

(1) You will find from your subject ID the stocks you are allowed to trade. But you can always view information about both stocks, including the one you can't trade.

(2) Recall the dividend information on the two stocks:

	Dividend of E (in Francs)	Dividend of I (in Francs)
State I (probability 0.50)	5	295
State II (probability 0.50)	295	5

(3) Earnings in dollars are computed by adding the francs remaining to dividend earnings and multiplying by the conversion rate of 0.0012.

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

(5) At the beginning of each period your starting endowment of francs, stock E, and stock I will appear at the bottom of your trading screen. Units of stocks E and I **do not** carry forward across periods. Your endowment will be the same at the beginning of each trading period.

Now let's practice trading.

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