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CLAREMONT MCKENNA COLLEGE

INDIVIDUAL vs. AGGREGATE DECISION MAKING – DIVERSIFICATION DISCOUNT

SUBMITTED TO:

PROFESSOR ANANDA GANGULY

AND

DEAN GREGORY HESS

BY

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FOR

SENIOR THESIS

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Section 1: Introduction

Many firms have operations in different segments. Such decisions to diversify presume that managers believe that diversification is more valuable for the firm than not being diversified. However, the market does not always value a diversified firm as the managers' or economists' models would imply. In fact, some studies found the suggestive evidence that diversified firms are actually valued at prices lower than non-diversified firms. This is contrary to economic theory and to managers' implicit motivation to diversify. The discount at which diversified firms trade is known as the "Diversification Discount". It is the difference in value between the diversified firms, and a portfolio of stand-alone firms comprising the divisions of the conglomerate.

There is no consensus as to whether diversification actually leads to lower firm value. One stream of scholars attributed the discount to statistical and measurement issues, such as sample selection biases and mismeasurement of diversification (Villalonga 2004). A second stream of scholars proposed inefficiency of conglomerates as the reason why diversification destroys value. For example, conglomerates may use profit from high-return divisions to subsidize low-return divisions (cross-subsidization). (Berger and Ofek 1995)

Yue and Zhou(2008) explain that diversified firms should be more valuable than the sum of the values of its divisions because of their real option value. Managers can redeploy assets from low-performing to high-performing divisions. They can close down divisions that lose money and expand profitable ones. Their theory posits that failure to recognize the real option value leads to diversification discount. However, they use market data to

observe if aggregate market prices behave as though their hypothesis is true. Therefore, they have no control over what market participants observe, and no way to measure how individuals react. Consequently, they can provide no direct test of their hypothesis. Their data can only show how portfolios buying firms in the highest real option value of diversification (RVD) decile and selling firms in the lowest RVD decile consistently provide positive return in 19 out of 22 sample years , but they cannot demonstrate whether these aggregate effects are due to people's misperception of the option value, or some other reason. For example, they cannot address whether people undervalue only the option, or whether they have difficulty combining values of divisions to arrive at values of the conglomerate (even without adding on the price of the option) or both.

This paper provides a direct laboratory test of whether the demonstrated diversification discount effect might be due to (1) individuals' not being able to combine values of divisions together linearly into a combined value; (2) their inability to recognize the advantage of the option; or (3) their inability to value it appropriately. Participants in this study trade securities with each other in a laboratory market setting. These securities are designed to represent either high-value or low-value segments. In certain periods, subjects are given the opportunity to convert their securities from one type to another, thus creating the option and therefore the option value.

Using the above methodology allows me the opportunity to observe whether participants in my experiments realize (1) that a low-performing segment can be shut down with the proceeds invested in the higher-performing segment to maximize expected value; (2) that this creates an option value such that the value of the two segments together is greater

than the value of the segments added together; and (3) whether resulting market prices reflect the option value or not. Also, when there are different market participants, such that some do realize these economic truths and others do not, the laboratory setting allows me to examine whether the "more rational" participants are able to exploit arbitrage opportunities and make a profit at the expense of the "less-rational" participants. My results also help to rule out some competing explanations as sole causes of the observed diversification discount. For example, some studies have argued that diversification leads to inefficiency and therefore destroys value of the firm (Jensen 1986). In my design, there is no inefficiency due to diversification, and any observed diversification discount must therefore be independent of inefficiencies of that nature. Lastly, the lab setting allows me to understand the conditions under which individual behavior described above leads to aggregate market data that show the diversification discount.

In my experiments, participants trade with each other in a market setting over a number of periods. Each period consists of 5 intervals. There are three types of securities: Yellow, Green and a combination of Yellow and Green securities (i.e., a Combo). Yellow securities represent low-expected-value divisions and Green securities represent high-expected-value divisions. Participants are allowed to convert the Yellows in their Combos to Greens and vice versa in certain periods, thereby operationalizing the option to move resources between divisions.

There are three treatment types in the experiments, the Baseline type, the Experience-effect type, and the Low-Risk-of-Conversion type. The differences between them involve

(a) the experience a subject has with payoffs from the Yellow and Green securities before making the conversion decision, and (b) the variance of payoffs between the two securities. In the Baseline type and the Low-Risk-of-Conversion type, participants make their conversion decisions early, before trading in the securities. Conversely, in the Experience-before-Decision type, participants make the conversion decision later, after a few periods of experiencing dividends from both securities. On the other hand the Low-Risk-of-Conversion type presents participants with a Green (high-expected-value) security with lower variance than corresponding Green securities in the Baseline and Experience-before-Decision types.

I find that people do understand there is the real option to convert from low-return security to high-return security. On average, participants at least convert some of their Yellows to Greens. Also, they recognize Combos with option to convert are more valuable than Combos without that option. However, the result is less conclusive as to whether subjects can price the option accurately. Furthermore, the Experience-effect treatment and the Low-Risk-of-Conversion treatment both seem to increase the likelihood of conversion from Yellow to Green. Lastly, "more rational" subjects are able to arbitrage and make a profit at the expense of "less rational" subjects.

The rest of this paper is organized as follows. I describe what previous studies have found on diversification discount in section 2. I discuss the methodology in section 3 and the results in section 4. Section 5 provides a Conclusion and discussion of limitations.

Section 2: Diversification Discount – What it is

We can think of the diversification discount as occurring in two forms, a strong form discount and a weak form discount. A strong form discount can be said to exist when markets value conglomerate firms as lower than the combined value of the stand-alone components (i.e., the sum of the pieces). A weak form discount can be said to exist when markets value firms at higher than the combined value of the stand-alone components, but lower than their combined value inclusive of the option value.

Managers consciously make the decision to diversify (Campa and Kedia 2000). Economic theories dictate that they would only diversify when the benefits of diversification outweigh the costs of diversification. They would choose to specialize when the costs of diversification outweigh the benefits of diversification. Therefore, the market value of the diversified firm should theoretically at least equal to the value of a comparable portfolio of stand-alone firms. The costs and benefits of diversification should be at least the same if firms choose to diversify.

Many previous studies found the existence of diversification discount. Lang and Stulz(1994) found that the Tobin's q of diversified firms had significantly lower average and median q ratios than single-segment firms.[1] Berger and Ofek (1995) found a 13% - 15% average loss in firm value if a firm chose to diversify. Lins and Servaes(1999) found an average of a 7% discount for diversified firms in seven emerging markets.

Yue and Zhou (2008) go further to argue that conglomerates should be valued higher than the firm-level aggregated return on asset (ROA) when their real option values are taken

[1] Tobin's q is the present value of future cash flows divided by the replacement cost of tangible assets.

into account. The real option value comes from a diversified firm's ability to expand profitable segments and close down segments that are losing money. That is, diversified firms can redeploy assets from low-return segments to high-return segments, therefore making their values theoretically greater than the sums of their low-return and high-return segments.

The real option theory dictates that a business should be valued at the convex function of its profitability. Failure to recognize this valuation convexity could cause diversified firms to be undervalued and hence traded at a discount. (Yue and Zhou 2008)

----------Insert figure 1 here----------

On the other hand, some studies cast doubt on the existence of diversification discount. Graham, Lemmon and Wolf (2002) found that diversified firms were valued lower because the business units they acquired were already discounted. Villalonga (2004) found that there was actually diversification premium when using the Business Information Tracking Series (BITS) to measure diversification. In short, there is no consensus as to whether diversification discount exists.

There are several explanations for the diversification discount when it is observed. The first is that there is really no diversification discount and the decrease in value is merely due to data artifacts or statistical issues such as sample selection bias and mismeasurement of diversification. Graham, Lemmon and Wolf (2002) challenged the standard assumption. They argued that there is a sample selection bias because firms that

choose to diversify are firms that are underperforming when compared to the average specialized firm in the same industry in the first place. Villalonga(2004) questioned the measurement of diversification because the actual degree of diversification in a firm is usually greater than is reported. Campa and Kedia (2000) suggest that there is self-selection in the decision to diversify. There is also a negative correlation between firms' choice to diversify and firm value.

Secondly, some studies argued that diversification leads to inefficiency and therefore destroys value of the firm. Hence, it leads to the diversification discount. Berger and Ofek (1995) attributed the decline in firm value to overinvestment and cross-subsidization. Jensen (1986) suggested that managers have incentives to increase the size of the firm past the optimal point in order to control more resources and receive more compensation. Therefore, mergers and acquisitions may not be in the best interest of the firm. Diversification may destroy value because managers may have other intention other than to increase firm value.

Research Questions:

There are five alternative possibilities I examine in this paper: (1) Participants for some "behavioral-bias" reason value the combination of the parts as less than the sum of the two parts taken separately (i.e., strong-form diversification discount); (2) Participants do not realize the option advantage. Therefore, they do not choose to convert underperforming segments to better-performing segments (i.e., weak-form diversification

discount resulting from not realizing the advantage of the option); (3) Participants do choose to convert and are therefore aware of the advantage, but do not value the option appropriately in terms of price. (4) If participants can observe dividends of the different segments before deciding whether to convert, they are more likely to convert and/or price the option more appropriately. I call it the experience-before-decision effect. (5) People are more likely to convert low-return securities to high-return securities and price the option more appropriately if the variance of the high-return security is lower. In other words, the diversification discount is likely to be lower if the high-return security is less risky.

Section 3: Methodology

The experiment is conducted under a market setting. Participants trade securities with each other in the market via double oral auctions. Three types of securities are traded in the experiment. They are Green, Yellow and a combination of Green and Yellow securities called the "Combo". The Yellow and Green securities can yield either a high dividend (a good state) or a low dividend (bad state). The dividend that the security yields is positive in a good state and negative in a bad state. The probability that a good or bad state will occur, and the dividend values in each, are pre-determined by the experimenter and revealed to the subjects beforehand.

----------Insert figure 2 here----------

----------Insert figure 3 here----------

----------Insert figure 4 here----------

The Combo security consists of one Yellow security and one Green security. The Combo security has to be traded as a whole on the market. In other words, the participants are not allowed to separate a Combo security into its components and trade the Yellow and Green securities individually on the market. All securities last for one period and have no value at the end of the period.

----------Insert figure 5 here----------

----------Insert figure 6 here----------

----------Insert figure 7 here----------

----------Insert figure 8 here----------

Each session of the experiment comprises eleven periods and there are five intervals in each period. In other words, intervals are the subcomponents of a period. At the inception of all periods, the participants are allotted two securities (either Yellow, Green, or Combo) and a loan of 70,000 experimental Francs, the currency used in the experiments. Only one type of security is traded in a particular period. The loan has to be returned at the end of the period, but the securities are retained as an endowment. Participants can use the loan to purchase securities in the market from other participants, or sell any securities they own. Trading of securities only occurs in Interval 1 of each period, while participants receive dividends from their securities in Intervals 1 through 5. All trading is conducted using a double oral auction market. The figure below shows how the periods are subdivided into intervals.

----------Insert figure 9 here----------

Participants receive dividends based on the number of units of securities they have on hand at the time the dividend is revealed. Dividends are received in each interval of a period. Thus, in each period, a security pays out dividend five times, once per interval. As mentioned before, the dividend amount depends on whether the security yields a good or bad state. The state that the security experiences is determined independently from interval to interval. Therefore, in the same period, the security can be in different states during different intervals.

As mentioned earlier, Combo securities are really combinations of one Yellow and one Green. Therefore, a Combo security yields two dividends, one for the Yellow and the other for the Green. The two dividends are independent of one another and based on the probabilities revealed to the participants earlier for each type of securities.

As mentioned earlier, there are three treatment types in the experiments, the Baseline type, the Experience-effect type, and the Low-Risk-of-Conversion type. The differences between them involve (a) the experience a subject has with payoffs from the Yellow and Green securities before making the conversion decision, and (b) the variance of payoffs between the two securities. In the Baseline type and the Low-Risk-of-Conversion type, participants make their conversion decisions early, before trading in the securities. Conversely, in the Experience-before-Decision type, participants make the conversion decision later, after a few periods of experiencing dividends from both securities. On the other hand the Low-Risk-of-Conversion type presents participants with a Green (high-expected-value) security with lower variance than corresponding Green securities in the Baseline and Experience-before-Decision types.

The first six periods of each experimental session comprised two periods involving Yellow securities, two periods involving Green securities, and two periods involving Combo securities without a conversion option. The purpose of these first six periods was to establish benchmark pricing for Yellow, Green, and a simple no-conversion portfolio of one Yellow and one Green.

The subsequent five periods of each experimental session involve Combo securities with a conversion option. As in all other periods, trading occurs in interval 1. However, in the third interval within the period, participants have the opportunity to convert the Yellow security in the Combos they own to a Green security and vice versa. For Intervals 1 and 2, dividends are calculated based on the mix of Yellow and Green securities they hold before any conversion. For Intervals 3 through 5, dividends are calculated based on the mix of securities after conversion.

While conversion in these periods is always effective from the 3rd through the 5th intervals of the period, the decision is made at different points across my three treatments. In the Baseline and Low-Risk-of-Conversion treatments, the decision is made prior to trading in Interval 1, i.e., a the outset. In the Experience-before-Decision treatment, the decision is made at the start of Interval 3 after experiencing dividends in Intervals 1 & 2.

Section 4: Results

Research Question One:

The first research question is whether, due to some behavioral-bias, people value the combination of the parts as less than the sum of the two parts taken separately (i.e., do the lab data suggest a strong-form diversification discount as defined earlier).

People do seem to value Combo-No-Conversion lower than the sum of Yellow and Green taken separately. The first row of Table 2 shows the t-test of buying-price differences Combo-No-Conversion and the sum of Yellow and Green securities. The first four columns show result of t-tests comparing the price differences between Combo-No-Conversion and sum of Yellow and Green to zero for each subject. Overall, there is not enough evidence to conclude that people value Combo-No-Conversion differently than sum of Yellow and Green. However, in the EBD type and the Low-Risk-of-Conversion type, the differences are negative and are statistically significant at 5% and 10% levels respectively, showing a strong form diversification discount. Thus, no definite conclusion can be drawn as to whether the strong-form of diversification exists in the experiment. While the overall results seem consistent with no strong-form bias, there did seem to be a bias of that nature in the EBD and Low-risk-of-Conversion treatments.

Research Question Two:

The second research question is whether people realize the option advantage. That is, do they choose to convert underperforming segments to better-performing segments when given a costless opportunity to do so (i.e., weak-form diversification discount resulting from not realizing the advantage of the option).

Table 1 shows the differences between the number of Green and Yellow security as a percentage of the total number of security after conversion. The difference is calculated as follows.

$$\frac{No.of\ Green}{No.of\ Green + No.of\ Yellow} x\ 100\% - \frac{No.of\ Yellow}{No.of\ Green + No.of\ Yellow} x100\%$$

If people do not convert at all, the difference should be zero as Green and Yellow each make up half of the total number of securities before conversion. If the difference is positive, it means that people on average converted Yellow to Green. If the difference is negative, it means that people on average converted Green to Yellow.

----------Insert Table 1 here ----------

The first four columns in Table 1 test whether the differences between Green percentage and Yellow percentage are statistical significantly different from zero. As Table 1 shows, the differences are positive and significant at 1% overall and for each treatment type individually. People tend to convert their Yellows to Greens. Thus, the results show that subjects on average do understand they have a real option. They understand Green is better than Yellow and know to convert to their own advantage.

Research Question 3:

The third research question investigates whether participants value the option appropriately in terms of price.

First, I look at the differences in mean between prices of Combo without the option to convert (Combo-No-Conversion) and Combo with the option to convert (Yes-Combo). The differences are calculated as follows.

$$(Price\ of\ Combo - No - Conversion) - (Price\ of\ Yes - Combo)$$

If the differences are positive, it means that the market price of Combo-No-Conversion is on average higher than that of Yes-Combo. If the differences are negative, it means that the market price of Yes-Combo is on average higher than that of Combo-No-Conversion.

I separately analyze the buy and sell price of the each type of security across different periods for each subject. Table 2 shows t-tests of Buying Price Differences between Combo-No-Conversion, the Sum of Green and Yellow and Yes-Combo. The second row of Table 2 shows results of testing if the differences in buy prices between Combo-No-Conversion and Yes-Combo are statistically different from zero. For overall, the Base type (significant at 5% level) and the Experience Effect type (significant at 1% level), the differences are negative. Although for the Low-Risk-of-Conversion type, the difference is positive, it is not statistically significant. Participants do price Yes-Combo higher than Combo-No-Conversion. It suggests that they understand Yes-Combo carries a real option which is valuable.

----------Insert Table 2 here ----------

Next, I examine if people can price the real option appropriately. The real option value should be 120 Francs.[2] Table 3 shows the prices differences between Yes-Combo and Combo-No-Conversion and whether it is less than the real option value of 120. The price difference is calculated as follows.

[2] The real option is effective from the third interval to the fifth interval. The value of the option is calculated as the difference between the expected value of Green(50 Francs) and Yellow(10 Francs) per interval multiplied by 3.

$$(Price\ of\ Yes - Combo) - (Price\ of\ Combo - No - Conversion)$$

A positive number means price of Yes-Combo is higher than price of Combo-No-Conversion and vice versa.

Overall, the one-tail t-stat that price differences are less than 120 is not statistically significant. Participants on average are able to price the real option appropriately.

----------Insert Table 3 here----------

The last three columns of Table 3 also shows the one-tail t-tests result of the price differences between Yes-Combo and Combo-No-Conversion.

The difference between Combo-No-Conversion and Yes-Combo is lower than 120 in Base type (significant at 1% level) and Low-Risk-of-Conversion type (significant at 1% level). However, difference is higher than 120 in Experience Effect Case (significant at 1% level). Different treatment type may have an effect on participants' valuation of the real option. Alternatively, small sample size may be the reason for the observed differences. It is clear that people understand the real option is valuable. They seem to be able to price the option appropriately on average.

Research Question 4:

My fourth research question asks if participants who observe dividends of the different segments for a few iterations before deciding whether to convert are more likely to convert and/or price the option more appropriately than participants who evaluate the securities without experiencing any returns (i.e., the Experience-before-decision effect).

The third to last columns of Table 1 compares differences between Green and Yellow securities as a percentage of the total number of securities after conversion between the Base type and the Experience-before-Decision type (EBD). The negative difference between the Base type and EBD type indicates that people are more likely to convert Yellow to Green in the EBD type than in the Base type. Although not statistically significant, results do incline towards the conclusion that experience before decision increases the likelihood that people convert from Yellow to Green.

The Regression result also points towards the same direction. Table 5 is the regression result of percentage of Green in the total mix of security regressed on …. The coefficient of the dummy variable for EBD treatment is positive (significant at 5%). People are more likely to convert from Yellow to Green under the EBD treatment.

----------Insert Table 5 about here ----------

Research Question 5:

The fifth research question examines whether people are more likely to convert low-return securities to high-return securities and price the option more appropriately if the variance of the high-return security is lower. In other words, the diversification discount is likely to be lower if the high-return security is less risky.

The last column of table 1compares the differences between percentage of Green and Yellow securities after conversion between the Baseline type and Low-Risk-of-

Conversion type. The negative difference between the Baseline type and the Low-Risk-of-Conversion type indicates that people are more likely to convert Yellow to Green in the Low-Risk-of-Conversion type than in the Baseline type. Although not statistically significant, results do incline towards supporting a higher likelihood of conversion if variance of high-return security is lower.

The Regression result also points towards the same direction. Table 5 is the regression result of percentage of Green in the total mix of security. The coefficient of the dummy variable for Low-Risk-of-Conversion treatment is positive (significant at 5%). People are more likely to convert from Yellow to Green under the Low-Risk-of-Conversion treatment.

Table 2 and 4 shows the differential in buy prices and differential in sell prices between Combo-No-Conversion and Yes-Combo respectively. The last column compares the differential between Baseline type and the Low-Risk-of-Conversion type. A negative number in both buy and sell price indicate that the people value the real option higher in the Low-Risk-of-Conversion type than in the Baseline case.

----------Insert Table 4 here----------

Section 5: Conclusion and Discussion

In this paper, I examine through laboratory experimentation whether diversification discounts can exist in a lab setting, and some conditions which exacerbate or mitigate the effect. More specifically, I examine whether people understand the real option value of a

business. Also, I want to find out if EBD effect and Low-Risk-of-Conversion affect whether people exercise the real option.

Subjects do convert from Yellow (low expected value of dividend) to Green (high expected value of dividend). People understand that Green is better than Yellow. They also are likely to convert Yellow to Green to maximize their profit. In the experiment setting, people understand conglomerates have real option to redeploy assets.

Results are less conclusive as to whether people are able to value the real option correctly. Overall speaking, the buy premium[3] of Yes-Combo over Combo-No-Conversion is not statistically different from the true real option value. However, there is variation across treatment type. The premium ranges from 65.90(significant at 1% level) Francs to 199.93(significant at 1% level) Francs while the true real option value is 120 Francs. Subjects sometimes undervalue the real option and sometimes overvalue the real option. The different treatment types may have affected how subjects value the real option. When comparing the Base Case with the Low-Risk-of-Conversion type, the buy premium is higher by 20 Francs in the latter case. It can be due to the lower variance of Green (high expected value of dividend) in the Low-Risk-of-Conversion type than in the Base type. When the expected value of Green remains the same and the variance decreases, Green becomes more attractive. The value of the real option also increases. For EBD case, subjects can be more aware of the real option value after observing two intervals of dividend return before making the conversion decision. However, more definite

[3] The buy price of Yes-Combo minus that of Combo-No-Conversion of individual subjects.

conclusion can only be drawn after expanding the sample size by running more sessions of the experiment.

The EBD treatment seems to increase people's likelihood to convert Yellow to Green. The mean of Green percentage is higher than in the Base Case. Also, the regression shows that when controlled for other factors, the EBD treatment increases the percentage of Green. More people are likely to convert Yellow to Green under EBD treatment than in the Base Case. People may be more aware of the downside of Yellow and upside of Green after observing dividends for two intervals. In turn, they are more likely to convert.

The result for Low-Risk-of-Conversion treatment is also in the expected direction. People are more likely to convert Yellow to Green under the Low-Risk-of-Conversion treatment than in the Base Case, controlled for the inherent risk averseness of the individuals. When variance for Green decreases, it is more attractive as an option.

Another finding I got unexpectedly is that some people think that they do not convert all their securities from one type to another because they want to diversify. Table 5 shows the regression of Green security as a percentage of all securities against various variables. The variable Q13 represents people's responses in the 13th question of the post-experiment questionnaire (PEQ). The question is ": I would not convert all my securities to one type (i.e. all Yellow or all Green) because I want to diversify." The coefficient is negative (significant at 1% level). The more participants agree with the statement, the more unlikely that they would convert Yellow to Green. It may be one of the explanations why managers do not redeploy assets from low-return to high-return segments. Further studies can be done on the issue.

Bibliography:

Berger, P. and E. Ofek. 1995. Diversification's Effect on Firm Value. *Journal of Financial Economics* 37(1995): 39-65

Campa, J. and S. Kedia. 2000. Explaining the Diversification Discount. Research Division IESE, University of Navarra, Research Paper No. 424

Jensen M. 1986. Agency Costs of Free Cash Flow, Corporate Finance, and Takeovers. *American Economic Review*, 76(2): 323-329

Lang, L.H.P. and R. Stulz. 1994. Tobin's q, Corporate Diversification, and Firm Performance. *Journal of Political Economy,*102(6):1248-1280

Lins, K. and H. Serveas. 1999. International Evidence on the Value of Corporate Diversification. *Journal of Finance* 54:2215-2240

Villalonga, B. 2004. Diversification Discount or Premium? New Evidence from the Business Information Tracking Series. *The Journal of Finance,* 59(2):479-506

Yue, H. and X. Zhou. 2008. Valuation Convexity and Diversification Discount. Working Paper

	1 sample t-test	2 sample t-test

Table 1:

1-tail t-test of differences between percentage of Green Security and Yellow Security

	Differences between Green % and yellow %	n	***significant at 1% level ** significant at 5% level * significant at 10% level
Overall	0.44***	153	
Base Type	0.38***	67	
Experience-before-Decision(EBD) Type	0.57***	22	
Low-Risk-of-Conversion Type	0.46***	64	
Base Type vs EBD Type	-0.19		
EBD Type vs Low-Risk-of-Conversion Type	0.109		
Base Type vs Low-Risk-of-Conversion Type	-0.08		

Table 2:

1-tail t-test of buy price differences between No-Combo, the sum of Green and Yellow and Yes-Combo

	Overall	Base Type	Experience-before-Decision(EBD) Type	Low-Risk-of-Conversion Type	Base Type vs EBD Type	EBD Type vs Low-Risk-of-Conversion Type	Base Type vs Low-Risk-of-Conversion Type
Buy Price No-Combo – Buy Price of (Green + Yellow)	-82.01	24	-177.5**	-124.4*	201.5	-53.1	148.4
n	15	5	2	8			
Buy Price No-Combo – Buy Price Yes-Combo	-17.34	-70.32**	-193.08***	86.63	122.76***	-279.71**	-156.95*
n	21	5	5	11			
***significant at 1% level ** significant at 5% level * significant at 10% level							

Table 3:

1-tail t-test if mean of price difference between Yes-Combo and No-Combo and 120

	Overall	Base Type	EBD Type	Low-Risk-of-Conversion Type
Mean Price Difference between Yes-Combo and No-Combo	108.625	65.90***	199.93***	85***
n	56	21	15	20
***significant at 1% level ** significant at 5% level * significant at 10% level				

Table 4:

1-tail t-test of sell price differences between No-Combo, the sum of Green and Yellow and Yes-Combo

	1 sample t-test				2 sample t-test		
	Overall	Base Type	Experience-before-Decision (EBD) Type	Low-Risk-of-Conversion Type	Base Type vs EBD Type	EBD Type vs Low-Risk-of-Conversion Type	Base Type vs Low-Risk-of-Conversion Type
Sell Price No-Combo – Sell Price of (Yellow + Green)	-177.67***	-204.79***	-196.46	-145.84*	-8.33	-50.61	-58.95
n	18	8	2	8			
Sell Price No-Combo – Sell Price Yes-Combo	-6.64	-96.00***	-184.29***	107.87*	88.28***	-292.15**	-203.87**
n	27	8	5	14			
***significant at 1% level ** significant at 5% level * significant at 10% level							

Table 5:

Regression of percentage of Green security on treatment types and various control variables

	Coefficient	Standard Error
Gender(Male=1, Female=0)[+]	0.14	0.11
Economics/Finance(Major in Econ/Finance =1)[+]	0.31***	0.11
School Year(Freshmen=1, Sophomore=2, etc)	-0.14**	0.05
Tendency to convert to Green[4]	-0.03	0.03
Tendency to convert to Yellow[5]	0.02	0.03
Control for Endowment effect 1[6]	-0.05**	0.02
Control for Endowment effect 2[7]	0.07*	0.04
Control for perception of riskiness[8]	-0.16***	0.04
Control for Risk Preference[9]	-0.02	0.03
Tendency to diversify[10]	-0.06***	0.02
Subject Risk Averseness[11]	0.00	0.04
Risk Aversion Treatment[+]	0.22**	0.09
Experience-before-Decision Treatment[+]	0.30**	0.13
[+] Dummy variable		

[4] Q7 of post-experiment questionnaire(PEQ): I exchanged Green securities for Yellow whenever I was allowed to do so

[5] Q8 of PEQ: I exchanged Yellow securities for Green whenever I was allowed to do so

[6] Q9 of PEQ: When I did not exchange one security for another, it was because it was my security-- good or bad-- and I was going to do the best with it

[7] Q10 of PEQ: When I did not exchange one security for another, it was because the security I had was better for me than the alternative I could have gotten in exchange. In retrospect, it would be better if I have a separate question for Green and Yellow security respectively.

[8] Q11 of PEQ: When I did not exchange one security for another, it was because the security I had was in my opinion less risky than the security I could have gotten in exchange

[9] Q12 of PEQ: I would rather have a smaller return which is more certainty than a bigger return that is less certain.

[10] Q13 of PEQ: I would not convert all my securities to one type (i.e. all Yellow or all Green) because I want to diversify

[11] Measured by a the lottery selection sheet in appendix 2. The higher the number, the more risk averse one is.

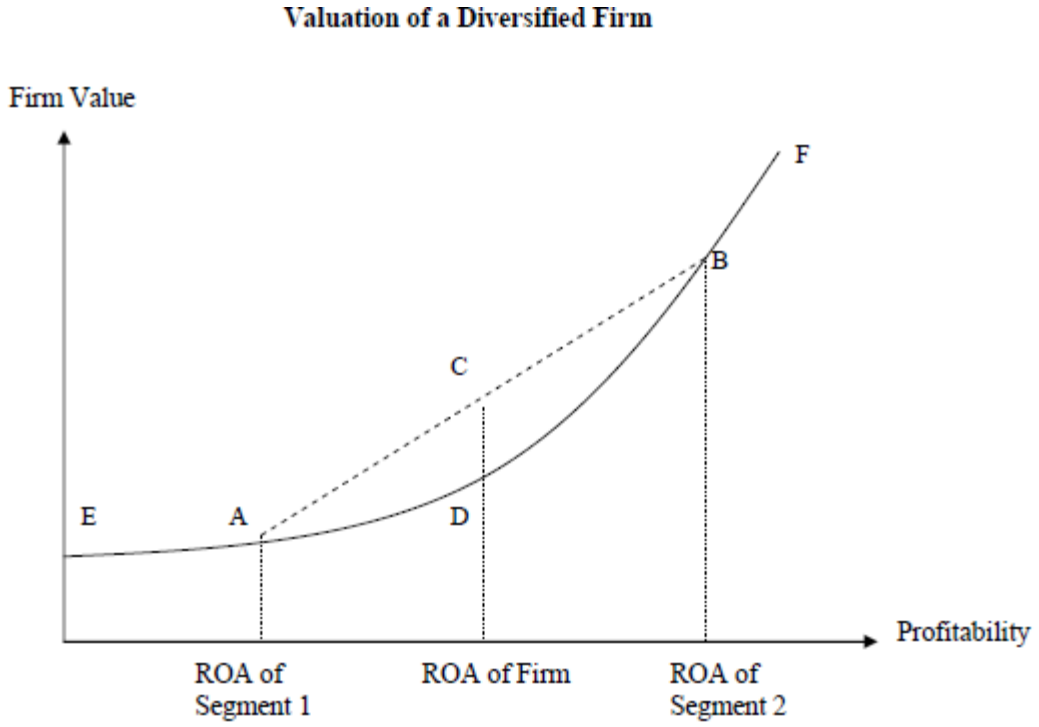


Figure 1 Yue and Zhou (2008)

	Yellow Security	
	Probability of State	Dividend in Francs
Good State	50%	400
Bad State	50%	-380

Figure 2: Yellow security - All types

	Green Security	
	Probability of State	Dividend in Francs
Good State	50%	300
Bad State	50%	-200

Figure 3: Green security - Baseline type and Experience Effect type

	Green Security	
	Probability of State	Dividend in Francs
Good State	50%	200
Bad State	50%	-100

Figure 4: Green security - Low-Risk-of-Conversion type

Combo Security(Consisting of 1 unit of Yellow and 1 unit of Green)- With the Option to Convert (effective from the 3rd interval in each period					
1 unit	Yellow Security		1 unit	Green Security	
	Probability of State	Dividend in Francs		Probability of State	Dividend in Francs
Good State	50%	400	Good State	50%	300
Bad State	50%	-380	Bad State	50%	-200

Figure 5: Combo with Conversion: Baseline type and Experience Effect type

Combo Security(Consisting of 1 unit of Yellow and 1 unit of Green)- With the Option to Convert (effective from the 3rd interval in each period					
1 unit	Yellow Security		1 unit	Green Security	
	Probability of State	Dividend in Francs		Probability of State	Dividend in Francs
Good State	50%	400	Good State	50%	200
Bad State	50%	-380	Bad State	50%	-100

Figure 6: Combo with Conversion: Low-Risk-of-Conversion type

Combo Security(Consisting of 1 unit of Yellow and 1 unit of Green)- No Conversion					
1 unit	Yellow Security		1 unit	Green Security	
	Probability of State	Dividend in Francs		Probability of State	Dividend in Francs
Good State	50%	400	Good State	50%	300
Bad State	50%	-380	Bad State	50%	-200

Figure 7: Combo-No-Conversion: Baseline type and Experience Effect type

Combo Security(Consisting of 1 unit of Yellow and 1 unit of Green)- No Conversion					
1 unit	Yellow Security		1 unit	Green Security	
	Probability of State	Dividend in Francs		Probability of State	Dividend in Francs
Good State	50%	400	Good State	50%	200
Bad State	50%	-380	Bad State	50%	-100

Figure 8: Combo-No-Conversion: Low-Risk-of-Conversion type

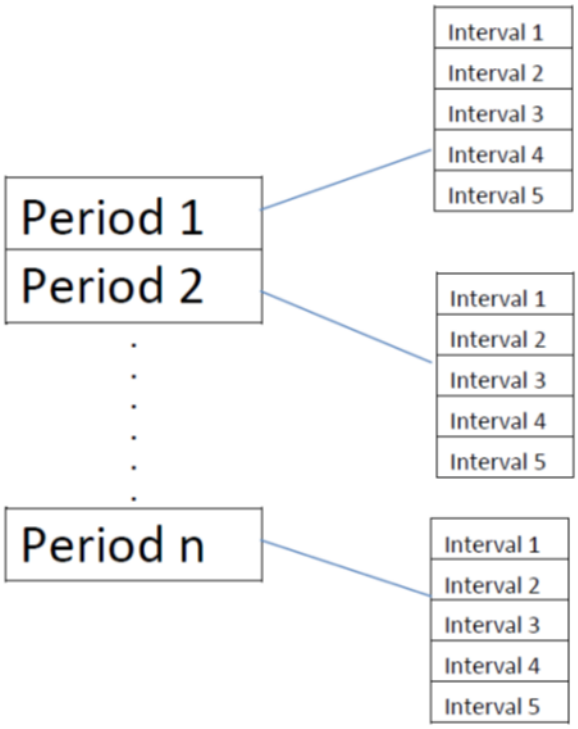

Period 1
Period 2
Period n
Interval 1
Interval 2
Interval 3
Interval 4
Interval 5
Interval 1
Interval 2
Interval 3
Interval 4
Interval 5
Interval 1
Interval 2
Interval 3
Interval 4
Interval 5

Figure 9

Appendix 1: Experiment Instructions

INSTRUCTIONS

General

Thank you for agreeing to participate in today's experiment. If you have not already done so, please read and sign the consent form, and ask if you have any questions. You may also take a copy of the consent form with you if you want. You may make any notes, scribbles, etc. as you wish on anything except the consent form. (But please leave all materials behind for us to collect when you leave this room.)

You will be paid a participation fee of $3.00 for participating in today's experiment. This flat fee is over and above any profits you make in this experiment as described below. However, if you make any losses in the experiment, they will be deducted from this flat fee.

In today's experiment, you are invited to make good economic decisions and earn profits in the process. (There are no "correct" answers. Good decisions are those that will help you earn the highest profits.) All transactions throughout today's experiment will be conducted in an experimental currency we'll call *Francs*. The rate of exchange will be 400 *Francs* = U.S. $1.00. At the end of today's experiment your entire profit in *Francs* will be converted to U.S. Dollars and paid to you in cash immediately.

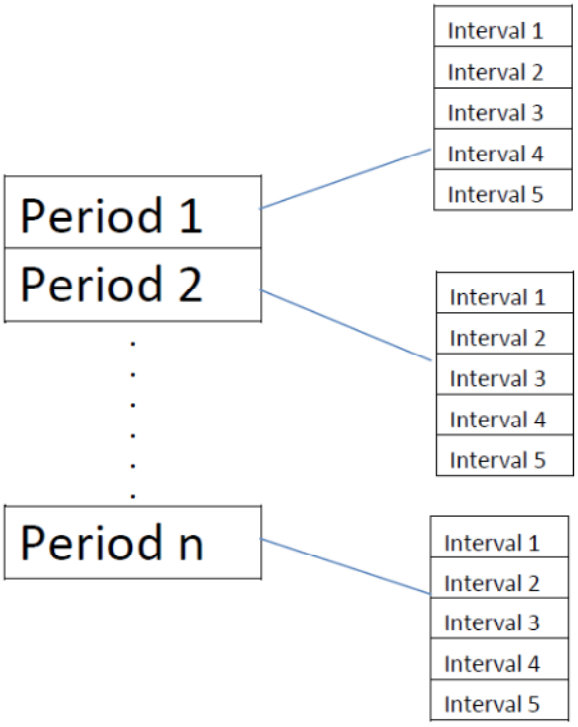
Task 1: Pick a lottery

Your first task is to pick a lottery. There are ten pairs of lottery choices listed on the sheet given to you. Each pair has two lotteries, A and B. For each pair, please write down the lottery you would prefer to play. At the end of the experiment, we will pick one of these ten pairs of lotteries at random. Both lotteries in that pair will then be played out, and you will get your prize based on your pick in that pair.

Task 2: You as an investor

Overview of task 2

Task 2 is not related to Task 1. In this task, you are an investor. You will be trading in a financial market with the other participants in this room for a number of periods. Each period is divided into five intervals. Trading will occur in interval 1 of each period and dividends will be paid out in intervals 1 through 5. Below is a graphical illustration of the overall organization of task 2.



The securities you will be trading with today

Before each period, the experimenters will provide you with some shares of financial security (i.e., like a share of company stock) that will be traded in that period. There can be three types of securities although only one type will be traded in any period. The three types of securities will be called "Yellow," "Green," and a non-separable combination (or bundle) of one Yellow and one Green, which we'll call a "Combo." A Combo can only be traded as a complete bundle. You will not be allowed to separate the Green and Yellow components of the Combo and trade those components separately. However, in certain intervals of certain periods, you will be given the opportunity to convert either component of the Combo for the other. For example, in one such "conversion" interval, where you have three Combo securities, you have the option to convert any of the Yellow components of your Combos to Green components and vice versa. More information will be provided regarding the conversion of securities later.

There is a printed document titled "List of Security" in front of you. In each period, please refer to that for information on securities to be traded in that period.

How you trade your securities

You can buy or sell only one unit of a security at a time in an oral auction. To buy securities you can call out a BID price, i.e., the price at which you would buy a security. To sell securities, you can similarly call out an ASK price i.e., the price at which you sell a security. Please raise your placard and wait until you are called on to yell out your BID or ASK. All bids and asks will be displayed in public view until a transaction is completed. Your BID (to buy) must be higher than any outstanding bid from another participant; your ASK (to sell) must be lower than any outstanding asking price. A transaction will occur when someone accepts an outstanding bid or ask.

Recording a transaction

Whenever a transaction occurs, the two individuals involved (the buyer and the seller) in the trade will record the transaction on their pre-programmed MSExcel™ Spreadsheet. Several transaction columns have been provided on the spreadsheet (the orange and blue cells). In each trading period, please record your first transaction in the "Trans 1" column, your second transaction in the "Trans 2" column and so on. Under each transaction column, you will see "BUY" and "SELL" sub-columns. The buyer will record the price in his/her appropriate "BUY" sub-column (orange), and the seller will record the same price in his/her appropriate "SELL" sub-column (blue). You need to record only the price of the transaction. The spreadsheet program will take over from that one entry and update your cash and security balances. For example, if in period 1, you first buy a security at $400 and later sell a security at $500, your Excel spreadsheet should be filled in as below:

		Avail.				Count	Count	Tran 1		Tran 2		Tran 3	
		Cash	Yellow	Green	Combo	buy	sales						
PERIOD	INTERVAL							Buy	Sell	Buy	Sell	Buy	Sell
1	1	70100	2			1	1	400			500		
1	2												
1	3												
1	4												
1	5												

How a period is organized and how your profit is calculated

At the start of each period, we will give you some securities of one of the types described above (Yellow, Green or Combo) and an interest-free returnable loan of 70,000 *Francs* in cash. The securities are yours to keep. During the trading interval in the period, you are encouraged to buy more securities with the cash, or sell your securities and get more cash, the objective being

to make as much profit as you can. At the end of each period, you will repay the cash loan. The securities you hold will pay a dividend in each interval of each period, but will cease to exist at the end of the last interval of each period (i.e., they will pay five dividends and then cease to exist). Your profit in each interval can be described by the following equation:

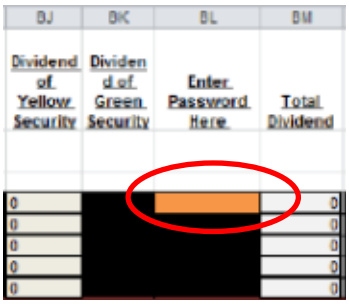
Profit = Cash received by selling securities (if any) – Cash paid for buying securities (if any)

+ (No. of Yellow securities held at end of interval x *dividend per Yellow security in that interval)*

+ (No. of Green securities held at end of interval x *dividend per Green security in that interval)*

Please note that you can increase your profits in three ways: (1) by buying a security for a low price and selling it for a high price; (2) by selling a security at higher than its total five-interval dividends; and (3) by buying a security at lower than its total five-interval dividends. Probability information provided to you will help you predict a security's future dividends. Please note that the dividends of the securities are determined independently in every interval. Also, dividend of Yellow is not related to dividend of Green in any way.

The dividend paid by each security will be publicly revealed after each interval. We will give you a password to input in column BL named "Enter Password Here". After you input the password, the spreadsheet will calculate your dividend income from the securities for the interval.

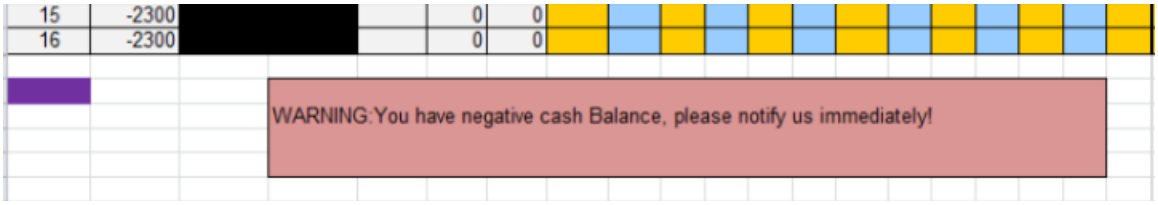


You will start each period with a fresh set of securities which are yours to keep, and a repayable loan of 70,000 Francs. The spreadsheet will calculate your available cash and security balances at all times during each trading period.

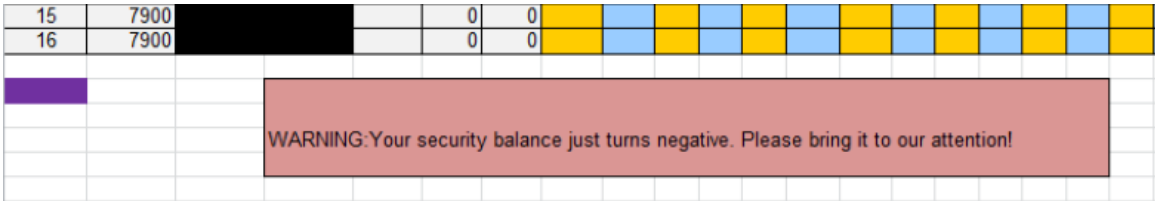
No buying without cash or short-selling

Please note that you may not use more than your existing cash balance to buy a security. You may continue to sell securities in the meantime if you wish, as long as you have securities available to sell. The spreadsheet will warn you if your cash balance turns negative as a result of

a purchase. Please keep a watch out for warnings in the “Warning Area” at the bottom of the spreadsheet.



Similarly, you may not sell securities that you do not currently have. The spreadsheet will warn you if your security balance turns negative for an attempted sale. Please keep a watch out for warnings in the “warning Area” at the bottom of the spreadsheet.



The option to convert from one type of security to another in a combo

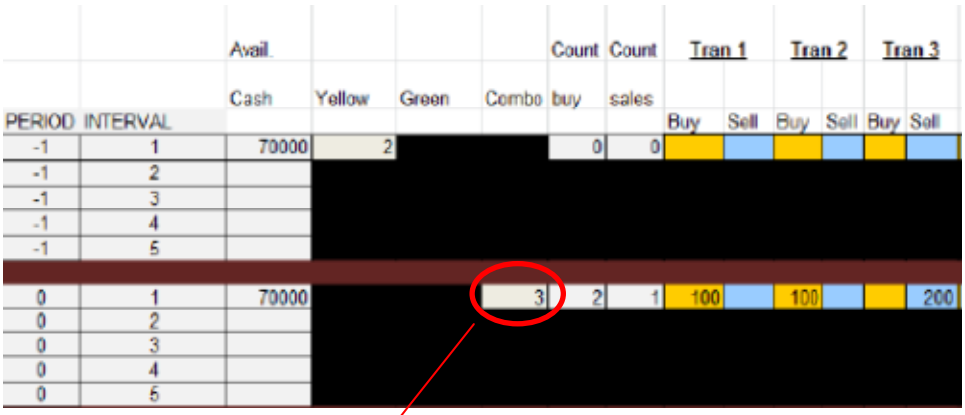
In periods when the security traded is a Combo, you will have the opportunity to convert any number of Yellow securities in your combos to Green securities and vice versa. The conversion will be effective from the interval as specified by us at the beginning of that period. For any intervening intervals before the conversion decision is implemented, you will receive dividends based on your original (pre-conversion) number of Green and Yellow securities in your Combo. For intervals after the conversion decision is implemented, you will receive dividends based on the new (post-conversion) numbers of the two types of securities.

Below is an example of the five intervals within one such period.

In Period N…	
	Interval 1 Trader K is allotted 1 combo (1 Yellow securitiy,1 Green security). No trading. Therefore, end-of-interval balance is still 1 Combo. Trader K receives dividend for 1 Yellow and 1 Green security in his Combo.
	Interval 2 Trader K receives dividend for 1 unit of Yellow and 1 unit Green security in his combo.
	Interval 3(Remember: this is only a sample! The details may change!) Trader K has the option to convert the any security in his combo for a security to another type. Trader K's decision will be implemented in the current interval (interval 3). He decides (say) to covert his Yellow for a Green. Now, he has 2 units of green security and 0 unit of yellow security. At the end of interval 3, experimenters reveal the dividend for a Yellow and dividend for a Green, but Trader K receives dividend only for a Green. (He does not own any Yellow and thus does not receive any dividend for his yellow security.)
	Interval 4 Trader K receives dividend for his 2 Greens.
	Interval 5 Trader K receives dividend for his 2 Greens.

When you have the option to convert: How do you communicate with us about your conversion decision?

After the trading interval has ended, we will come up to you and hand you your Conversion Decision Sheet. Please fill out the appropriate cells. Then we will collect the sheets from you. Below is an example. In **Period 0**, you have bought 2 units and sold 1 unit of Combo. Your original allotment of Combo at the beginning of the experiment is 2 units. Therefore, your ending balance of Combo is 3. You should put down 3 in the second column named "Combo balance after Trading". As there is 1 unit of Yellow and 1 unit of Green in each Combo, you have 3 units of Yellow and 3 units of Green on hand. If you want to convert 1 unit of your Yellow to Green, you will have **2 units of Yellow** and **4 units of Green** after conversion. You should put down 2 and 4 in the fourth and fifth columns respectively.

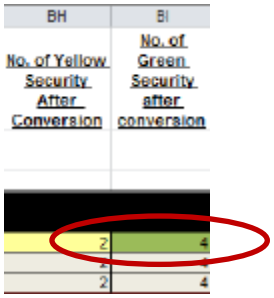


PERIOD	INTERVAL	Avail. Cash	Yellow	Green	Combo	Count buy	Count sales	Tran 1 Buy	Tran 1 Sell	Tran 2 Buy	Tran 2 Sell	Tran 3 Buy	Tran 3 Sell
-1	1	70000	2			0	0						
-1	2												
-1	3												
-1	4												
-1	5												
0	1	70000			3	2	1	100		100			200
0	2												
0	3												
0	4												
0	5												

Period	**Combo balance after trading**	**Calculation of Yellow and Green after trading**	**Units of Yellow you want to hold after conversion**	**Units of Green you want to hold after conversion**
0	3	x 1 = 3 Yellow x 1 = 3 Green	2	4

How to record the conversion of securities in a Combo in your Excel spreadsheet?

In your spreadsheet, please enter the number of Yellow and Green after conversion in the light green cell in the column titled “No. of Green Securities after Conversion” and in the light yellow cell in the column titled “No. of Yellow Securities after Conversion.” Continuing with the example above, your Excel spreadsheet should be filled in as follows:



BH	BI
No. of Yellow Security After Conversion	No. of Green Security after conversion
2	4
2	4

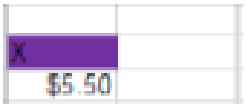
Time to practice!

We will now record a sample transaction in Period -1(without the option to convert) and Period 0(with the option to convert) (the practice periods) to see how this might work. Please go to the Excel sheet for the practice period. Please hit Ctrl-S frequently during the experiment (at least once at the end of each of your transactions) to save the data from mishaps.

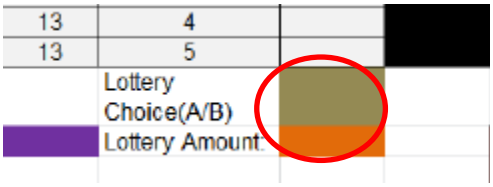
ARE THERE ANY QUESTIONS BEFORE WE BEGIN?

At the end of the experiment

At the end of the experiment, your programmed spreadsheet will show your ending cash balance in Francs. Please put an "x" in the purple box and your final cash balance in U.S. dollars will now be computed by the spreadsheet program. You will be paid the amount shown after we have verified the amount with our record.



Now we will play a pair of lotteries from your Task 1. Please enter your choice (A or B) in the cell provided on the spreadsheet for the purpose (see snapshot below) in the brown box. We will come over to collect your Pick a Lottery Sheet. Next, we'll release the outcome of each pair. Please enter the outcome relevant to you (based on your choice) next to the "Lottery Amount:" label on your spreadsheet(Orange box), as indicated below.



<u>End of –Experiment Questionnaire</u>

The experimenters will now hand out a post-experiment questionnaire which should only take a few minutes to complete. Please fill this out while experimenters are calculating/auditing your total earnings. After you have turned in this questionnaire, you will be given your payment in cash (U.S. dollars). That would conclude today's experiment.

Non-disclosure

Thanks for coming to the experiment and help me collect data for my thesis. We hope that you will have fun and earn some money in the experiment. You are welcome and even encouraged

to tell your friends that you had fun here. However, please do not disclose details about the experiment to your friends, including the task layouts, probabilities, payouts and your strategy. It is because we do not wish some traders would have more information than others, which would mess up the data set. I spend many hours designing the experiment and a considerable amount of my own money to run these experiments. I would really appreciate it if you keep the details of the experiment to yourselves.

Appendix 2 – Lottery Selection Sheet:

Trader Number:

Date:

Task 1 – Choose a Lottery!

There are ten pairs of lottery choices listed below. Each pair has two options, A and B. For each pair, please write down which of the two lotteries you would prefer to play. This sheet will then be collected by the experimenters. One of the ten pairs will be randomly chosen at the end of the experiment to play, and both options from that pair will be run. Your earnings from the lottery will depend on the outcome of your chosen option in that chosen pair. Your earnings from the lottery of your choice will be your first earning in this experiment, so please make your choice wisely to try to get the maximum amount of money from us.

Pair	Option A	Option B	Your Choice(A/B)
1	10% chance payoff of 800 Francs, 90% chance payoff of a 640 Francs	10% chance payoff of 1540 Francs, 90% chance payoff of a 40 Francs	
2	20% chance payoff of 800 Francs, 80% chance payoff of a 640 Francs	20% chance payoff of 1540 Francs, 80% chance payoff of a 40 Francs	
3	30% chance payoff of 800 Francs, 70% chance payoff of a 640 Francs	30% chance payoff of 1540 Francs, 70% chance payoff of a 40 Francs	
4	40% chance payoff of 800 Francs, 60% chance payoff of a 640 Francs	40% chance payoff of 1540 Francs, 60% chance payoff of a 40 Francs	
5	50% chance payoff of 800 Francs, 50% chance payoff of a 640 Francs	50% chance payoff of 1540 Francs, 50% chance payoff of a 40 Francs	
6	60% chance payoff of 800 Francs, 40% chance payoff of a 640 Francs	60% chance payoff of 1540 Francs, 40% chance payoff of a 40 Francs	
7	70% chance payoff of 800 Francs, 30% chance payoff of a 640 Francs	70% chance payoff of 1540 Francs, 30% chance payoff of a 40 Francs	
8	80% chance payoff of 800 Francs, 20% chance payoff of a 640 Francs	80% chance payoff of 1540 Francs, 20% chance payoff of a 40 Francs	
9	90% chance payoff of 800 Francs, 10% chance payoff of a 640 Francs	90% chance payoff of 1540 Francs, 10% chance payoff of a 40 Francs	
10	100% chance payoff of 800 Francs, 0% chance payoff of a 640 Francs	100% chance payoff of 1540 Francs, 0% chance payoff of a 40 Francs	

Appendix 3 – Post-experiment Questionnaire:

Task 3: Post-Experiment Questionnaire

1. Trader Number:

2. Date: _____ 3. Approximate time: _____

4. Gender (Circle one :) MALE / FEMALE

5. Academic Major _____

6. Year in School (Circle one :) FRESHMAN / SOPHOMORE / JUNIOR / SENIOR/GRADUATE

7. I exchanged Green securities for Yellow whenever I was allowed to do so:

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|
-3      -2      -1       0      +1      +2      +3
```

8. I exchanged Yellow securities for Green whenever I was allowed to do so:

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|
-3      -2      -1       0      +1      +2      +3
```

9. When I did not exchange one security for another, it was because it was my security-- good or bad-- and I was going to do the best with it.

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|
-3      -2      -1       0      +1      +2      +3
```

10. When I did not exchange one security for another, it was because the security I had was better for me than the alternative I could have gotten in exchange

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|
-3      -2      -1       0      +1      +2      +3
```

11. When I did not exchange one security for another, it was because the security I had was in my opinion less risky than the security I could have gotten in exchange

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|
-3      -2      -1       0      +1      +2      +3
```

12. I would rather have a smaller return which is more certainty than a bigger return that is less certain.

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|

-3      -2      -1       0      +1      +2      +3
```

13. I would not convert all my securities to one type (i.e. all Yellow or all Green) because I want to diversify.

```
Strongly Disagree                    Strongly Agree
|-------|-------|-------|-------|-------|-------|

-3      -2      -1       0      +1      +2      +3
```