

APPENDIX

A. Modifications to the Presented Experiment

A.1 Including a third Treasury security type asset

U.S. Treasury securities carry a zero probability of default (and very low risk overall as the Treasury market is one of the most liquid markets in the world). This modification involves handing out a third paper of a different color which will represent this asset. Since it carries a zero probability of default, there is no need to do a raffle. The dividend (coupon) that this asset pays is 1 point per period.

A.2 Allowing students to short sell

Short selling refers to the practice of selling assets that the trader does not own at the time of the sale. The trader can borrow the assets to be sold, and later purchase identical assets for return. This is the usual practice if someone believes that a certain asset is currently overpriced and expects the market to correct the mispricing in the near future. Short selling is also usually undertaken for hedging purposes in combination with other trades.

Being short means that the trader owns a negative number of assets. If the asset price falls, the trader profits from having sold the borrowed asset for more than he later pays for it. However, if the asset price rises, the trader loses by having sold the asset for less than the price at which he later has to pay for it. By purchasing a shorted asset the trader closes his position. Proponents in favor of short selling argue that it provides liquidity to the markets and is good form of market correction. However, critics of short selling argue that it can create panic in the financial markets leading to a spiral of downward movements.

This modification requires the students to interact between themselves in order to borrow and lend assets to be shorted as well as record the number of borrowed/lent assets. An asset can be borrowed for one period and then should be returned back to their owner in the next period. This is consistent with the usual practice in the bond markets where the majority of transactions are overnight and a security is lent out for one day. However the instructor may choose to extend the borrowed period to more than one.

A.3 Bonds with different maturities

Bonds have different maturities, whether these are issued by corporations, agencies, municipalities, or the federal government. Typically short-term bonds have a maturity of up to 1 year, intermediate bonds have a maturity from 1 to 10 years, and long-term bonds are the ones with more than 10 years remaining to maturity. In the case of Treasury bonds the longest-term bonds issued last for 30 years, while for corporations there are bonds with an original time to maturity of 100 years. Liquidity is more prevalent in short-term bonds, while long-term bonds remain idle in investors' portfolios.

An interesting extension of the described experiment is to have one of the assets mature earlier than the other (for example, after 5 periods rather than 8). This means that the asset pays a coupon only until period 5 (if it survives). The face value is also paid at the end of period 5.

A.4 Bonds with option-like features

Bonds can come with certain option-like features, such as callable, or puttable bonds. In the case of callable bonds the issuer has the right to *call* (buy back) the bond from its holder at a prespecified price (callable price) prior to maturity. Because of this advantage given to the issuer, the yield (return) from this bond is usually higher than a comparable plain vanilla (straight) bond

to compensate the holder for being exposed to this risk. A puttable bond can be put (sold back) to the company by the holder at a prespecified price (puttable price) prior to maturity. Because of the advantage given to the holder of the bond, the yield from this bond is lower than a plain vanilla bond. Callable bonds are a big part of the corporate bond market, and to a lesser extent the puttable bonds.

To accommodate the inclusion of these bonds to the existing setup implies that the instructor has to specify the callable (puttable) price which can be different from the face value, and the time that this bond can be called by (put back to) the issuer. The instructor will serve as the issuer, thus he would need an initial endowment to carry out any transactions regarding these bonds.

B. Instructions

This experiment will set up a financial market. Traders will be given both cash and paper bonds that pay future coupons. Traders need to make decisions as to what their paper assets are worth so that they can decide at what prices they would be willing to buy or sell assets. The detailed structure of the game is as follows:

Players and Assets

TRADING TEAMS: There are 5 trading teams: A, B, C, D, and E.

ASSETS: Each team starts with:

1. Six different assets, three of which are represented by sheets of blue colored paper and the other three by red colored paper.
2. 400 point cash account that can be used for buying other assets.

EARNINGS: Trading teams make money from:

1. collecting a 5 point dividend paid on each blue asset at the end of each trading period.
2. collecting a 20 point dividend paid on each red asset at the end of each trading period.
3. buying and selling assets.
4. cashing in 100 points for any assets (both blue and red) that survive until end of the eighth trading period.

FAILURES: There is a 20% chance that the red asset will fail after each dividend payment and 5% chance that the blue asset will fail. Once an asset fails, it is worthless, and I will tear up the sheet of paper that represents the asset. To determine failures, my assistant will come to all trading teams that own red or blue assets at the end of each trading period, after the dividends for

that period have been paid, and do a raffle where a pick of “1” will result in the destruction of the blue asset while a pick of either “1”, “2”, “3”, or “4” will result in the destruction of the red asset (out of numbers from “1” to “20”). Picks of any other number will allow the owner to keep or trade that asset in the next period. As already noted, any asset that is not destroyed by period eight will be redeemed for 100 points at the end of that period.

Trading Rules

TWO MARKETS: There will be two markets – one for blue and one for red assets.

TRADERS: Each team will have one person designated as the representative or “trader” for that team. Once the trading period begins, each trader is free at any time to raise a hand, and when called on, to make one of the several statements: a **BID** that expresses a commitment to buy an asset at a certain price; an **ASK** that expresses a commitment to sell an asset at a certain price; accepting the **BID** price given by another trader, and thus making a transaction to sell; or the acceptance of an **ASK** price given by another trader, and thus making a transaction to buy.

BIDS: If team A wishes to **BUY** a **RED** asset at 158 points, the trader for team A should place a **BID** for **RED** asset at 158 points. The bid tells others that team A is willing to buy one red asset from any of them at a price of 158 points.

ASKS: If a trader B wishes to **SELL** a **BLUE** asset at 189 points, trader B should place an **ASK** for **BLUE** asset at 189 points. The **ASK** tells all other traders that trader B is willing to sell one blue asset to any of them at a price of 189 points.

TRADERS: Suppose that the highest bid for a red asset is 158, from trader A, and the lowest ask for a red asset is 181, from trader B. Any of the traders who own assets can then decide whether

or not they want to sell a red asset to trader A in exchange for 158 points. If some trader wishes to sell, he or she must raise a hand, and when called on, say, "I hit A's bid for red asset at 158." Similarly, any of the other traders with sufficient cash on hand can decide whether or not to buy from trader B in exchange for 181 points. If some trader wishes to buy, he or she must raise a hand, and when called on, say "I take B's offering of red asset at 181." Instead of accepting someone else's bid or ask, a trader may simply enter a new bid or ask.

BID/ASK IMPROVEMENT RULE: I will record bids and asks for red and blue assets in two respective tables as follows:

RED	
BIDS	ASKS
A 158	B 181
C 159	D 179
A 162	

A new bid must be higher than the highest outstanding (untaken) bid, and a new ask must be lower than the lowest outstanding (untaken) ask. For example, the next bid must be above A's bid of 162, and the next ask must be below 179.

TRADES: A trade occurs only when one trader accepts another's bid or ask. When this occurs, someone from the seller's team should immediately deliver the sheet of paper representing the corresponding asset to the buyer's team, and both teams should adjust their cash positions: the buyer's cash goes down by the amount of the price, and the seller's cash goes up by the amount of the price. Once a trade is made, I will circle the price and erase all outstanding bids and asks, which are automatically cancelled. You are free to reenter previous bids or asks, however.

RULES: Any trader may make both bids during a period, but to make a bid, must have enough cash on hand, and to make an ask on blue or red market, must have at least one respective asset, i.e. one sheet of colored paper, blue or red (no short sales). All bids and asks are for a single asset, although a trader may buy or sell more than one asset during a period.

CLOSING BELL: The period will end after 3 minutes, regardless of whether the traders have completed all the trades they wish to make.

SUMMARY:

BID to buy and ASK to sell.

You may sell the specified red or blue asset by:

1. announcing an ask that someone else accepts, or
2. accepting someone else's bid price.

You may buy the specified red or blue asset by:

1. announcing a bid that someone else accepts, or
2. accepting someone else's asking price.

You cannot sell the asset that you do not have.

You cannot purchase an asset with money that you do not have.

RECORD KEEPING

1. There is a recording table for each period for both assets. Please see the samples for periods 1 and 2 on the next page. Always make sure that you are using the recording table for the correct period and for the correct asset.

2. Your trader letter is listed on the top left corner. The sample is for trader E.
3. Refer to the sample table for period 1 for the red asset. On line (0) notice that you have “Red Assets on Hand” of 3 and a “Cash Balance” of 400. Everyone begins period 1 with the same number of assets (3 red, 3 blue) and the same cash balance.
4. Line (1) shows that trader E’s first move in period 1 was to sell 1 red asset for 125. Trader E immediately records this amount in the Sale Price column of line 1. The Red Assets on Hand decrease from 3 to 2, and the cash balance increases from 400 to 525.
5. Line (2) shows that trader E’s second move was to buy 1 red asset for 150. This price is immediately recorded in the Purchase Price column of line 2. The Red Assets on Hand increase from 2 to 3, and the cash balance decreases by the amount of the purchase price, from 525 down to 375.
6. Line (3) shows that the trader’s third move in the period was to buy a red asset.
7. Line (4) shows that the trader’s fourth move in the period was to sell a blue asset.
8. Once the period is over, the trader records his/her final cash balance (the bottom number in the Cash Balance column) on line A near the bottom of the table. The number of blue assets is multiplied by the dividend amount of 5 points per blue asset to obtain the total dividends from blue assets for the period. In this case, $2 * 5 = 10$, which is entered in the right column of line B. The number of red assets is also multiplied by the dividend amount of 20 points per red asset to obtain the total dividends from red assets for the period. In this case, $4 * 20 = 80$, which is entered in the right column of line C. The end-period Cash Balance is obtained by adding the sums in lines A, B, and C and entering the sum ($325 + 10 + 80 = 415$) in the right column of line D.

9. After the dividends are paid, we will come to each team holding red and blue assets, and we will do the raffle. If the outcome for the blue asset is “1”, the asset will be torn up. If the outcome for the red asset is “1”, “2”, “3”, or “4”, the asset will be torn up. Then the number of remaining assets is entered in the Assets-on-Hand column of the table for the next trading period. The end-of-period cash balance is also transferred to the top of the Cash Balance column for the next period.
10. There will be 8 trading periods and any asset that has not been torn up after dividend payments in period 8 will be redeemed for 100. All cash earnings are hypothetical.
11. Please keep track of your earnings carefully, and raise your hand if you have any questions during the trading process.

Are there any questions?

Now please find your recording table for period 1. The red and blue markets are now open for bids and asks. Please do not call out a price until you are recognized.

Sample Recording Sheet

Trader E

Trading Period 1

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0				3	3	400
1	red	125		3	2	525
2	red		150	3	3	375
3	red		150	3	4	225
4	blue	100		2	4	325
5						
A					last cash balance	325
B					# blue assets * 5	10
C					# red assets * 20	80
D					end-of-period cash	415

Trader E

Trading Period 2

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						415

Recording Sheets for Periods 1-8

Trader _____

Trading Period 1

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0				3	3	400
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 2

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 3

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	

D					end-of-period cash	
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Trader _____

Trading Period 4

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 5

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 6

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	

C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 7

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

Trader _____

Trading Period 8

	Type of Asset (Blue or Red)	Sale Price	Purchase Price	Blue Assets on Hand	Red Assets on Hand	Cash Balance
0						
1						
2						
3						
4						
5						
A					last cash balance	
B					# blue assets * 5	
C					# red assets * 20	
D					end-of-period cash	

C. Results from Experiment (pooled results from two sessions described in the paper)

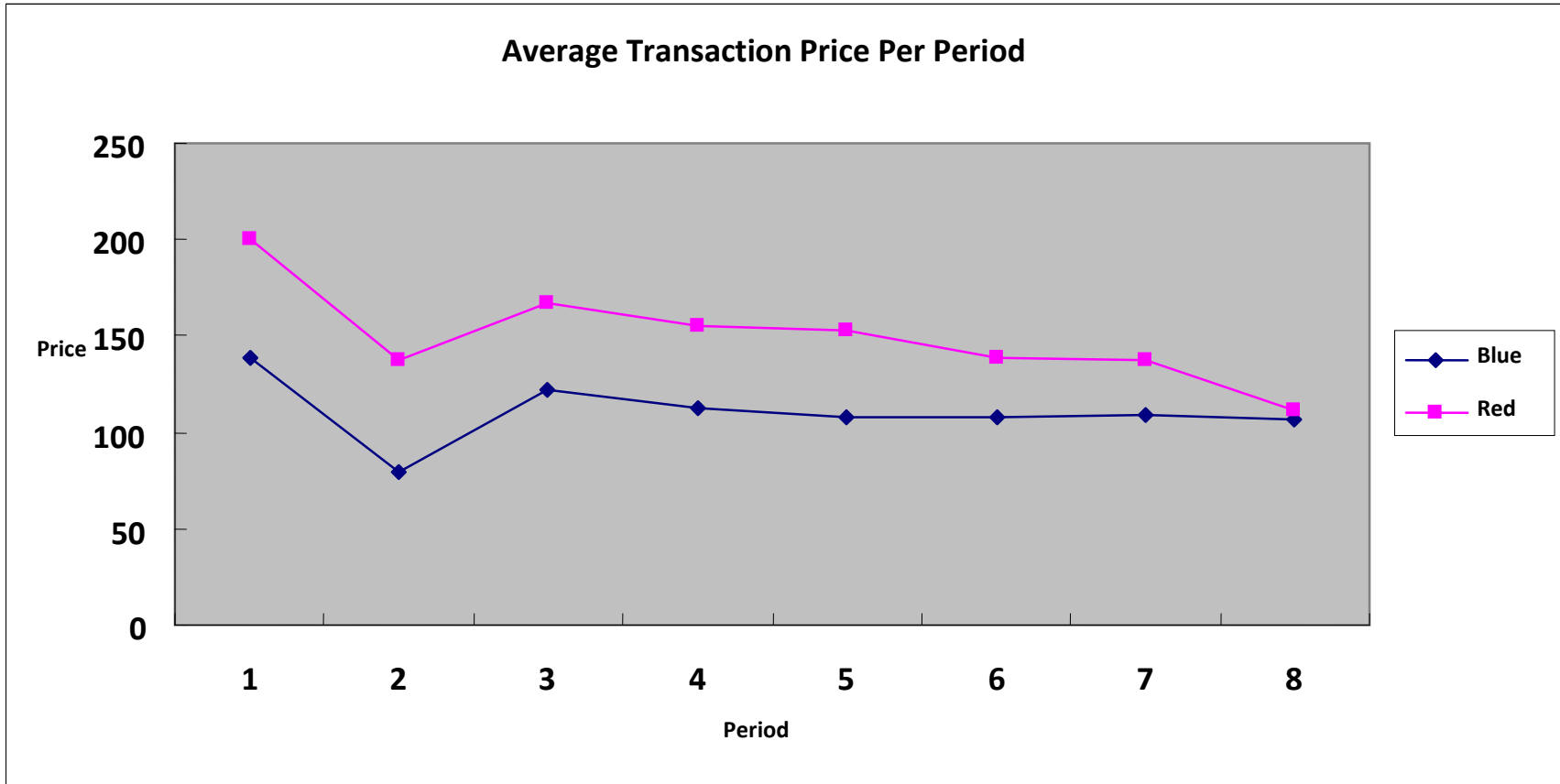


Figure 1. Average transaction price per period. This figure shows the average transaction price per period for each of the two assets.

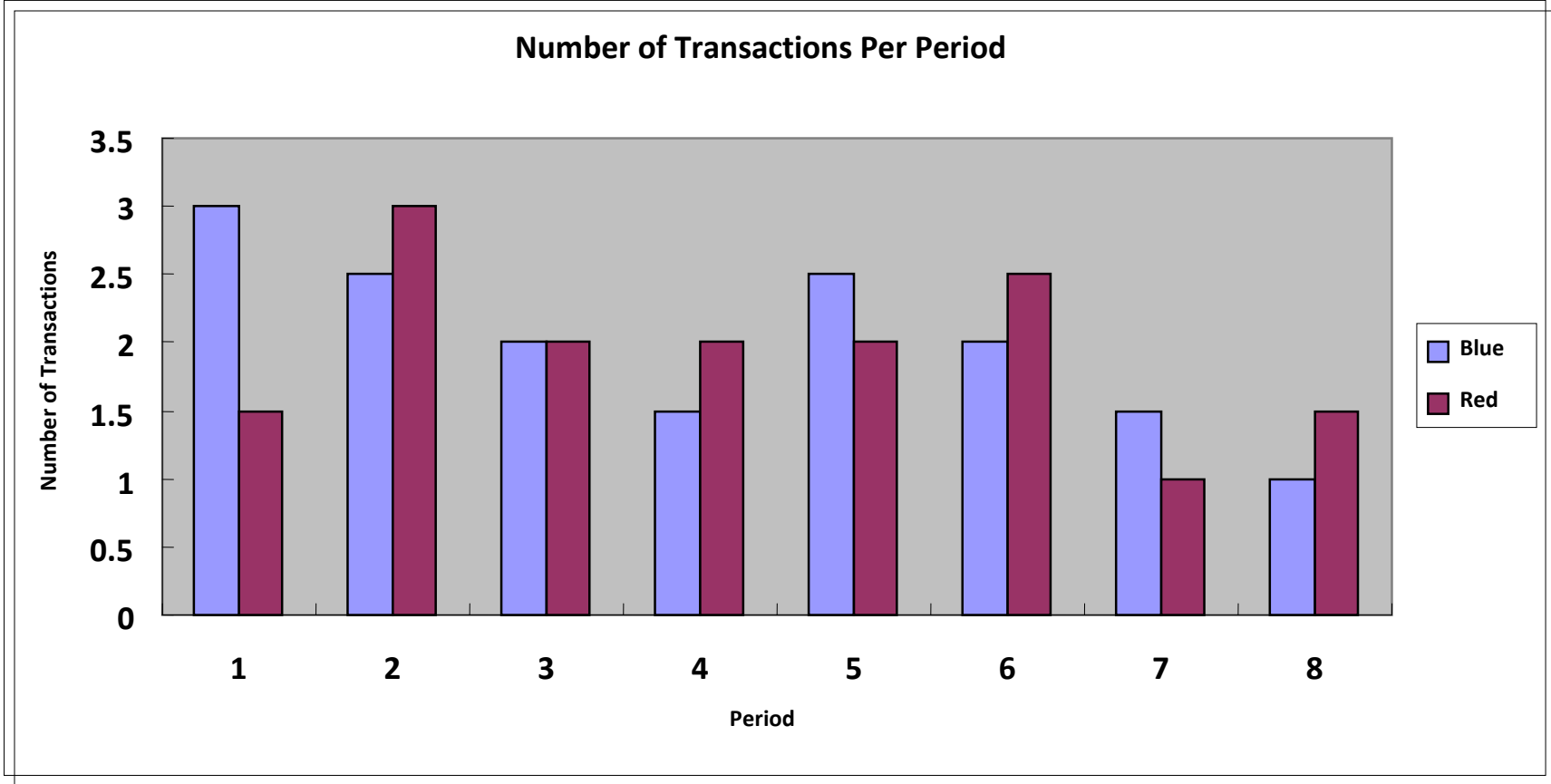


Figure 2. Number of transactions per period. This figure shows the number of transactions for each asset per period.

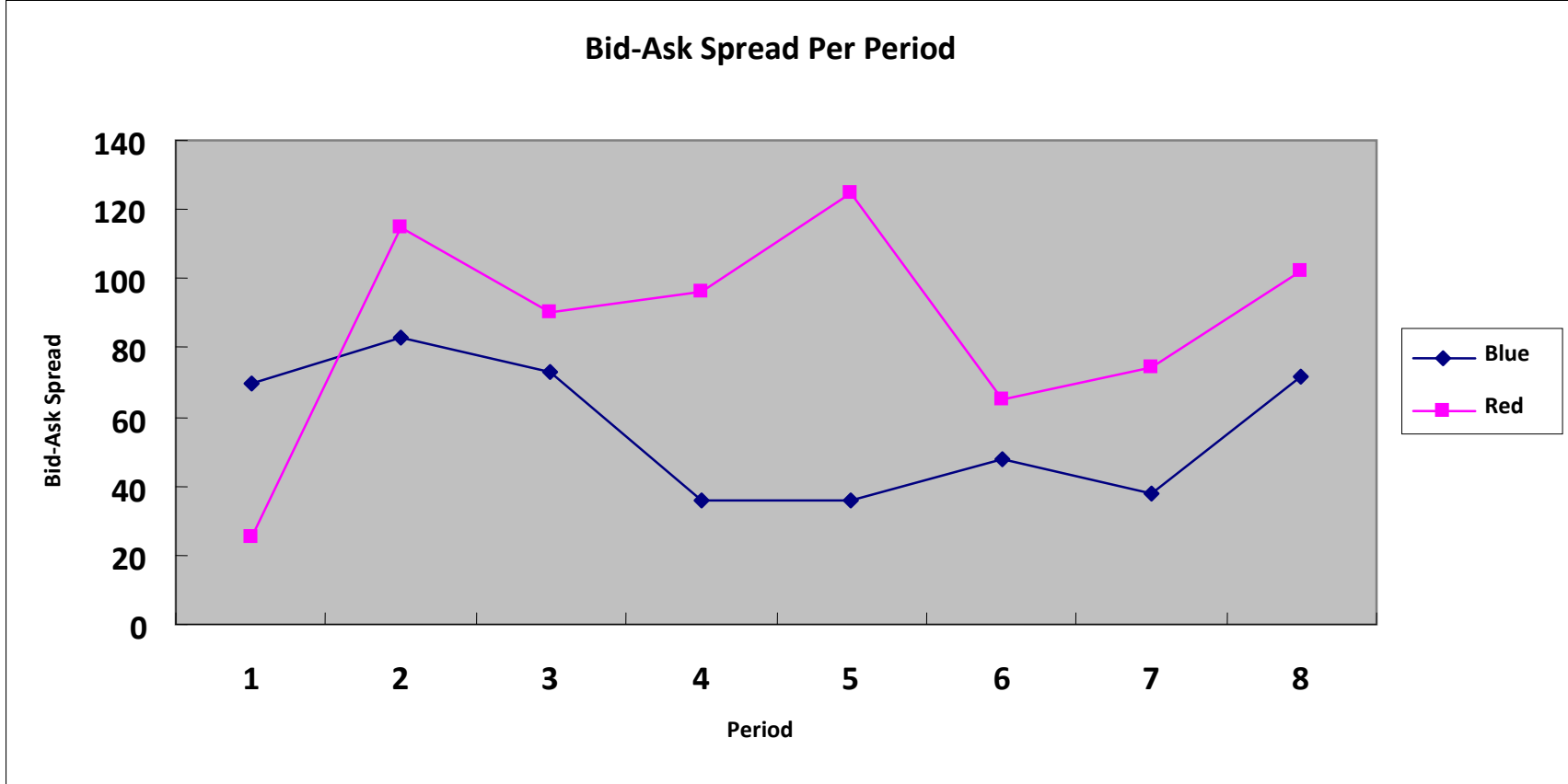


Figure 3. Bid-ask spread per period. This figure shows the range between the bid and ask price for each asset per period.