

Online Appendix I: Sample Instructions

Ring 6 network in the benchmark design

This is an experiment in the economics of decision-making. A research foundation has provided funds for conducting this research. Your earnings will depend on your decisions, on the decisions of the other participants in the experiments, and partly on chance. If you follow the instructions and make careful decisions, you may earn a considerable amount of money.

At this point, check the name of the computer you are using as it appears on the top left of the monitor. At the end of the experiment, we will call your computer name to pay your earnings. At this time, you will receive £5 as a participation fee (simply for showing up on time). Details of how you will make decisions will be provided below.

During the experiment we will speak in terms of experimental tokens instead of pounds. Your earnings will be calculated in terms of tokens and then exchanged at the end of the experiment into pounds at the following rate:

$$60 \text{ Tokens} = 1 \text{ Pound}$$

In this experiment, you will participate in 60 independent and identical (of the same form) rounds. In each round you will be assigned to a position in a six-person trading network for a commodity. You will be asked to choose an intermediation price that you will earn in case a seller and a buyer trade a commodity through you.

A round

We now describe in detail the process that will be repeated in all 60 rounds.

At the start of each round, you will be assigned with equal probability to one of the six network positions labeled *A*, *B*, *C*, *D*, *E*, or *F*. An equal number of the participants in the room will be designated in each of the six network positions. Your type (*A*, *B*, *C*, *D*, *E* or *F*) in each round depends solely upon chance and is independent of the types assigned to you in any of the other rounds.

The network and your type will be displayed at the left hand side of the screen (see Attachment 1). A line segment between any two types indicates that the two types are connected and that the commodity can be delivered between the two types.

Note that in the network used in this experiment,

- type-*A* participants can deliver the commodity either to type-*B* or type-*F*,
- type-*B* participants can deliver the commodity either to type-*A* or type-*C*,
- type-*C* participants can deliver the commodity either to type-*B* or type-*D*,
- type-*D* participants can deliver the commodity either to type-*C* or type-*E*,
- type-*E* participants can deliver the commodity either to type-*D* or type-*F*,
- and type-*F* participants can deliver the commodity either to type-*E* or type-*A*.

Next, the computer randomly forms six-person groups by selecting one participant of type-*A*, one of type-*B*, one of type-*C*, one of type-*D*, one of type-*E*, and one of type-*F* per group. The groups formed in each round depend solely upon chance and are independent of the groups formed in any of the other rounds.

After everyone is assigned to one type in one group, the computer will randomly select a pair of two non-adjacent types (no direct line segment between them) as a buyer-seller pair to trade the commodity. This is called a trading pair. Any pair of two non-adjacent types will be equally likely to be selected. Between two non-adjacent types in any trading pair, there will be at least one intermediary through which the commodity has to be delivered. Two participants in the selected trading pair will be highlighted in green color (see Attachment 1).

Once all participants in each group has been informed of the selection of a trading pair, each participant playing an intermediary role is asked to submit an intermediation price that will be charged if the trade occurs through the participant. Each participant can choose any real number (up to two decimal places) between 0 and 100. You will simply need to type the number you wish to choose in the number box at the bottom left of the screen and click the OK button. Note that if you are selected in a trading pair, you will not need to choose an intermediation price. Thus, you will not have a choice (see Attachment 2).

A surplus for each trading pair is 100 if trading occurs and zero otherwise. Trading will take place if there is at least one delivery route in which the sum of intermediation prices does not exceed the trading surplus of 100. If there is more than one such route, trading will occur through the route with the *lowest* sum of intermediation prices. If more than one route charges the same lowest sum of prices, one of such routes will be selected with equal probability for trading.

Note that in the network used in this experiment, there are always two possible delivery routes for any trading pair. For instance, if (A, E) is selected as a trading pair, the commodity can be delivered through F (route 1), or through $B, C,$ and D (route 2). Likewise, if (C, F) is selected as a trading pair, the commodity can be delivered through A and B (route 1), or through D and E (route 2).

Once everyone has made a decision, the computer will inform everyone about the choices of intermediation prices made by all the participants in your group, the trading route if trading occurred (highlighted in yellow color), and the earnings for a selected trading pair and intermediaries through which trading occurs (see Attachment 3).

After you observe the results of the first round, press the OK button at the bottom left of the screen to move on to the next round. The second round will start the computer randomly assigning types to all participants and forming new groups of six participants. Note that you can review the outcomes in previous rounds at the top right of the screen (see Attachment 1). This process will be repeated until all the 60 independent and identical rounds are completed. At the end of the last round, you will be informed the experiment has ended.

Earnings

Your earnings in each round depend on whether you are selected as one participant in the trading pair or as an intermediary. If you are selected in the trading pair, your earnings can be summarized in the following formula.

$$\text{Earnings} = 0.5 \times \{(\text{trading surplus}) - (\text{trading cost})\}$$

Note that the trading surplus is 100 if trading occurs and zero otherwise. The trading cost is the sum of intermediation prices that the trading pair must pay in order to make trading occur. If

trading does not occur, the cost is zero. Two participants in the trading pair share equally the net surplus. Thus, each participant in the pair earns half of the net surplus, as given in the formula.

If you are selected as an intermediary, your earnings are determined by intermediation revenue.

$$\text{Earnings} = (\text{intermediation revenue})$$

Your intermediation revenue is equal to your choice of intermediation price if trading occurs through you. If trading does not happen or does not occur through you, you will receive nothing.

To illustrate the determination of earnings further, let us take the following example. Suppose that (A, E) was selected as a trading pair. Suppose that B chose 10, C chose 40, D chose 25, and F chose 80 as their intermediation prices. Then, trading occurs through B , C , and D because the sum of intermediation prices on this route ($10 + 40 + 25 = 75$) is lower than the price charged by F (80), and does not exceed the trading surplus. Therefore, earnings six participants received are as follow:

$$\begin{aligned} (A\text{'s earnings}) &= 0.5 \times (100 - 75) = 12.5, \\ (B\text{'s earnings}) &= 10, (C\text{'s earnings}) = 40, (D\text{'s earnings}) = 25 \\ (E\text{'s earnings}) &= 0.5 \times (100 - 75) = 12.5, \\ (F\text{'s earnings}) &= 0. \end{aligned}$$

Let us take another example. Suppose that (B, E) was selected as a trading pair. Suppose that A chose 30, C chose 40, D chose 65, and F chose 80 as their intermediation prices. In this case, because each route of intermediaries charges the sum of prices exceeding the trading surplus – the sum of prices by A and F is 110 and the sum of prices by C and D is 105, trading cannot occur. Therefore, each participant's earnings are simply zero.

Your final earnings in the experiment will be the sum of your earnings over the 60 rounds. At the end of the experiment, the tokens will be converted into money. You will receive your payment as you leave the experiment.

Rules

Please do not talk with anyone during the experiment. We ask everyone to remain silent until the end of the last round.

Your participation in the experiment and any information about your earnings will be kept strictly confidential. Your payments receipt is the only place in which your name is recorded.

If there are no further questions, you are ready to start. An instructor will activate your program.

Attachment 1

Round

2 of 60

Round	Your type	Trading pair	Price A	Price B	Price C	Price D	Price E	Price F	Earnings
1	F	(B, E)	63.00	--	45.00	25.00	--	43.00	0.00

You are a type-A participant

(F, B) is chosen as a trading pair in this round

Please enter your price:

Attachment 2

Round

2 of 60

```
graph TD; A((A)) --- B((B)); B --- C((C)); C --- D((D)); D --- E((E)); E --- F((F)); F --- A;
```

Round	Your type	Trading pair	Price A	Price B	Price C	Price D	Price E	Price F	Earnings
1	E	(B, E)	63.00	--	45.00	25.00	--	43.00	15.00

You are a type-F participant

(F, B) is chosen as a trading pair in this round

You do not have to make a pricing choice in this round.

OK

Attachment 3

Round

2 of 60

```
graph TD; A((A)) --- B((B)); B --- C((C)); C --- D((D)); D --- E((E)); E --- F((F)); F --- A; style A fill:#f8d7da; style F fill:#d4edda; style B fill:#d4edda; linkStyle 0 stroke:#ffc107; linkStyle 1 stroke:#ffc107;
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Participant	Price	Trading	Buyer/Seller earnings	Intermediary Earnings
A	56.00	Yes	0.00	56.00
B	--	Yes	22.00	0.00
C	23.00	No	0.00	0.00
D	25.00	No	0.00	0.00
E	54.00	No	0.00	0.00
F	--	Yes	22.00	0.00

You are a type-A participant

(F, B) is chosen as a trading pair in this round

OK

Sample instructions: Ring 6 network with demand uncertainty

This is an experiment in the economics of decision-making. A research foundation has provided funds for conducting this research. Your earnings will depend on your decisions, on the decisions of the other participants in the experiments, and on chance. If you follow the instructions and make careful decisions, you may earn a considerable amount of money.

At this point, check the number of the computer you are using as it appears on the cubicle. At the end of the experiment, we will use your computer number to pay your earnings. At this time, you will receive £5 as a participation fee (simply for showing up on time). Details of how you will make decisions will be provided below.

During the experiment we will speak in terms of experimental tokens instead of pounds. Your earnings will be calculated in terms of tokens and then exchanged at the end of the experiment into pounds at the following rate:

$$30 \text{ Tokens} = 1 \text{ Pound}$$

In this experiment, you will participate in 60 independent and identical (of the same form) rounds. In each round you will be assigned to a position in a six-person trading network for a commodity with uncertain valuation. You will be asked to choose an intermediation price that you will earn in case a seller and a buyer trade a commodity through you.

A round

We now describe in detail the process that will be repeated in all 60 rounds.

At the start of each round, you will be assigned with equal probability to one of the six network positions labeled *A*, *B*, *C*, *D*, *E*, or *F*. An equal number of the participants in the room will be designated in each of the six network positions. Your type (*A*, *B*, *C*, *D*, *E* or *F*) in each round depends solely upon chance and is independent of the types assigned to you in any of the other rounds.

The network and your type will be displayed at the left hand side of the screen (see Attachment 1). A line segment between any two types indicates that the two types are connected and that the commodity can be delivered between the two types.

Note that in the network used in this experiment,

- type-*A* participants can deliver the commodity either to type-*B* or type-*F*,
- type-*B* participants can deliver the commodity either to type-*A* or type-*C*,
- type-*C* participants can deliver the commodity either to type-*B* or type-*D*,
- type-*D* participants can deliver the commodity either to type-*C* or type-*E*,
- type-*E* participants can deliver the commodity either to type-*D* or type-*F*,
- and type-*F* participants can deliver the commodity either to type-*E* or type-*A*.

Next, the computer randomly forms six-person groups by selecting one participant of type-*A*, one of type-*B*, one of type-*C*, one of type-*D*, one of type-*E*, and one of type-*F* per group. The groups formed in each round depend solely upon chance and are independent of the groups formed in any of the other rounds.

After everyone is assigned to one type in one group, the computer will randomly select a pair of two non-adjacent types (no direct line segment between them) as a buyer-seller pair to trade the commodity.

Any pair of two non-adjacent types will be equally likely to be selected. Between two non-adjacent types in any buyer-seller pair, there will be at least one intermediary through which the commodity has to be delivered. Two participants in the selected buyer-seller pair will be highlighted in green color (see Attachment 1).

A trading surplus for a buyer-seller pair is uncertain and will be drawn uniformly from the set of integers ranging from 1 to 100 at the beginning of each round. That is, any number from the set $\{1, 2, \dots, 100\}$ will be drawn with equal probability to be the value of surplus that a buyer and a seller will share if trading takes place. The draw of this value is independent of the values drawn for any other groups in the current round and any of the other rounds. This will be done by the computer.

Once all participants in each group have been informed of the selection of a buyer-seller pair, each participant playing an intermediary role is asked to submit an intermediation price that will be charged if the trade occurs through the participant. At this time, *none* of participants will be informed of the randomly drawn value of trading surplus. That is, each participant is asked to choose a price without knowing the value of surplus.

Each participant can choose any real number (up to two decimal places) between 0 and 100. You will simply need to type the number you wish to choose in the number box at the bottom left of the screen and click the OK button. Note that if you are selected in a buyer-seller pair, you will not need to choose an intermediation price. Thus, you will not have a choice (see Attachment 2).

The intermediation cost between a buyer and a seller is defined to be the *lowest* sum of intermediation prices of all possible delivery routes between them. Trading will occur through the route with the intermediation cost (the lowest sum of prices) if the cost is not higher than the randomly drawn value of trading surplus. If more than one route charges the same intermediation cost, one of such routes will be selected with equal probability for trading.

Note that in the network used in this experiment, there are always two possible delivery routes for any buyer-seller pair. For instance, if (A, E) is selected as a buyer-seller pair, the commodity can be delivered through F (route 1), or through $B, C,$ and D (route 2). Likewise, if (C, F) is selected as a buyer-seller pair, the commodity can be delivered through A and B (route 1), or through D and E (route 2).

Once everyone has made a decision, the computer will inform everyone about the choices of intermediation prices made by all the participants in your group, the intermediation cost, the value of trading surplus, the trading route if trading occurred (highlighted in yellow color), and the earnings for a selected buyer-seller pair and intermediaries through which trading occurs (see Attachment 3).

After you observe the results of the first round, press the OK button at the bottom left of the screen to move on to the next round. The second round will start the computer randomly assigning types to all participants, forming new groups of six participants, and randomly drawing values of trading surplus for all groups. Note that you can review the outcomes in previous rounds at the top right of the screen (see Attachment 1). This process will be repeated until all the 60 independent and identical rounds are completed. At the end of the last round, you will be informed the experiment has ended.

Earnings

Your earnings in each round depend on whether you are selected as one participant in the buyer-seller pair or as an intermediary. If you are selected in the buyer-seller pair, your earnings can be summarized in the following formula.

$$\text{Earnings} = 0.5 \times \{(\text{trading surplus}) - (\text{trading cost})\}$$

Note that any integer number between 1 and 100 will be drawn with equal probability to be the value of trading surplus if trading occurs. If trading does not occur, the value of surplus is zero. The trading cost is the intermediation cost that the buyer-seller pair must pay in order to make trading occur. If trading does not occur, the trading cost is zero. Two participants in the buyer-seller pair share equally the net surplus. Thus, each participant in the pair earns half of the net surplus, as given in the formula.

If you are selected as an intermediary, your earnings are determined by intermediation revenue.

$$\text{Earnings} = (\text{intermediation revenue})$$

Your intermediation revenue is equal to your choice of intermediation price if trading occurs through you. If trading does not happen or does not occur through you, you will receive nothing.

To illustrate the determination of earnings further, let us take the following example. Suppose that (A, E) was selected as a buyer-seller pair and the value of trading surplus for this pair is drawn to be 60. Suppose that B chose 10, C chose 15, D chose 25, and F chose 65 as their intermediation prices. Then, trading occurs through B , C , and D because the sum of intermediation prices on this route ($10 + 15 + 25 = 50$) is lower than the price charged by F (65), and thus the intermediation cost, 50, does not exceed the trading surplus, 60. Therefore, earnings six participants received are as follow:

$$(A's \text{ earnings}) = 0.5 \times (60 - 50) = 5,$$

$$(B's \text{ earnings}) = 10, (C's \text{ earnings}) = 15, (D's \text{ earnings}) = 25$$

$$(E's \text{ earnings}) = 0.5 \times (60 - 50) = 5,$$

$$(F's \text{ earnings}) = 0.$$

Consider another example in which all is the same as the above example except that the value of surplus is drawn to be 40. Because each route of intermediaries charges the sum of prices exceeding the trading surplus 40, trading cannot occur. Therefore, each participant's earnings are simply zero.

Your final earnings in the experiment will be the sum of your earnings over the 60 rounds. At the end of the experiment, the tokens will be converted into money. You will receive your payment as you leave the experiment.

Rules

Please do not talk with anyone during the experiment. We ask everyone to remain silent until the end of the last round.

Your participation in the experiment and any information about your earnings will be kept strictly confidential. Your payments receipt is the only place in which your name is recorded.

If there are no further questions, you are ready to start. An instructor will activate your program.

Attachment 1

Round 2 of 60

Round	Your type	Buyer Seller pair	Value	Price A	Price B	Price C	Price D	Price E	Price F	Earnings
1	D	(B, F)	23	28.00	--	25.00	10.00	8.00	--	0.00

You are a type-C participant

(E, B) is chosen as the buyer/seller pair in this round

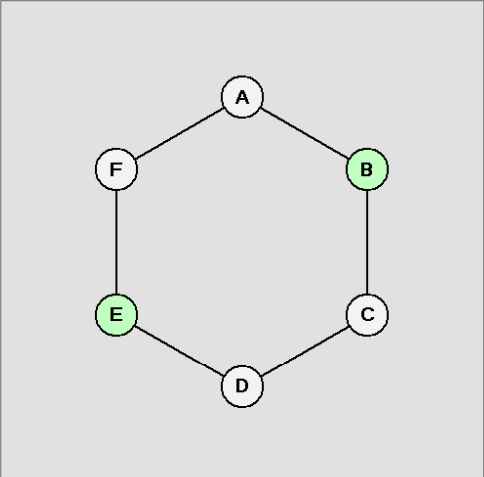
Please enter your price:

OK

Attachment 2

Round

2 of 60



Round	Your type	Buyer Seller pair	Value	Price A	Price B	Price C	Price D	Price E	Price F	Earnings
1	F	(B, F)	23	28.00	--	25.00	10.00	8.00	--	0.00

You are a type-E participant

(E, B) is chosen as the buyer/seller pair in this round

You do not have to make a pricing choice in this round.

OK

Attachment 3

Round

2 of 60

Participant	Price	Trading	Buyer/Seller earnings	Intermediary Earnings
A	22.00	No	0.00	0.00
B	-	Yes	29.00	0.00
C	20.00	Yes	0.00	20.00
D	10.00	Yes	0.00	10.00
E	-	Yes	29.00	0.00
F	15.00	No	0.00	0.00

You are a type-C participant

(E, B) is chosen as the buyer/seller pair in this round

The value of trading surplus in this round is 88.

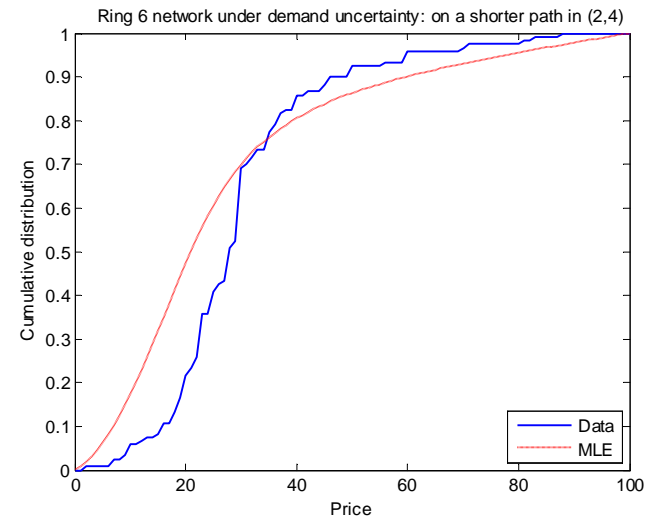
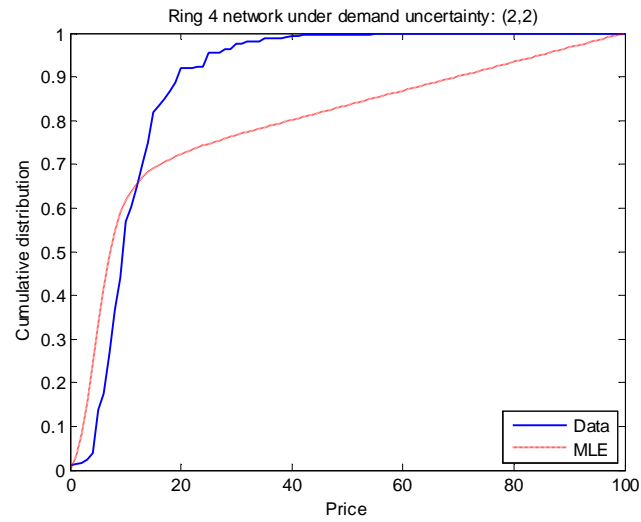
The intermediation cost is 30.

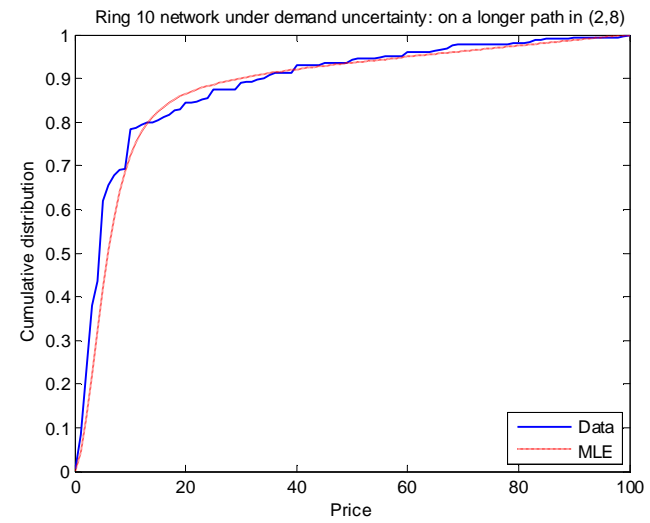
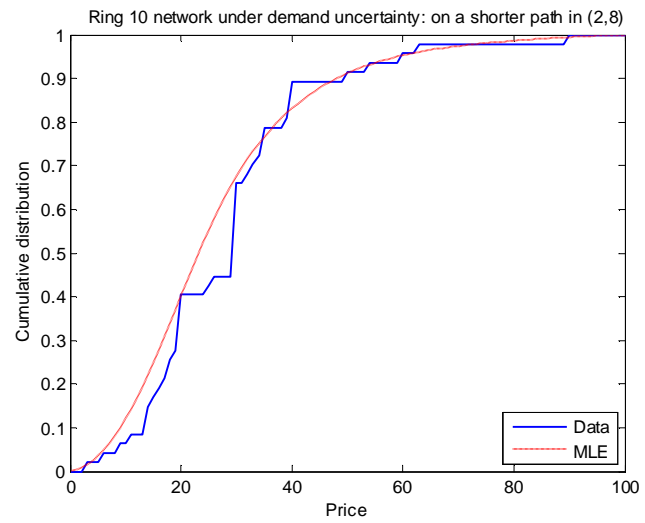
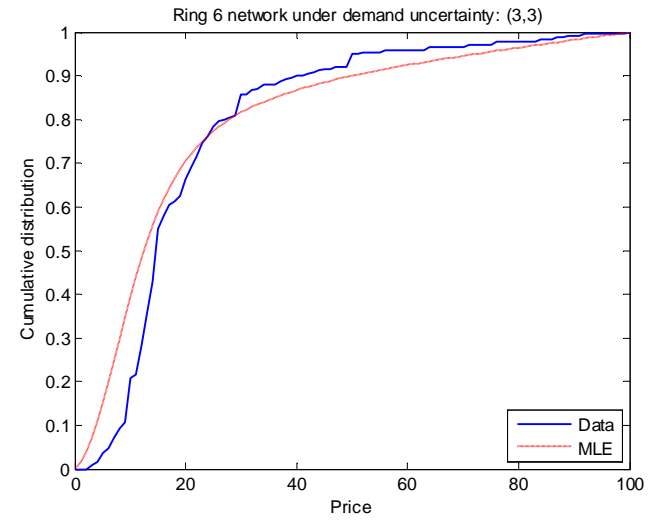
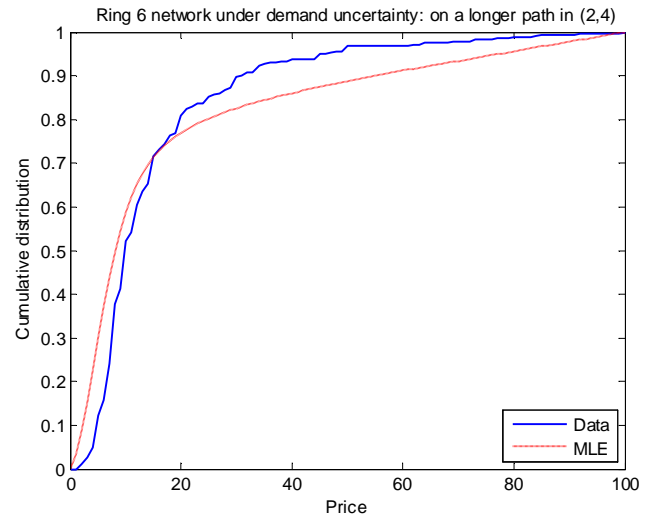
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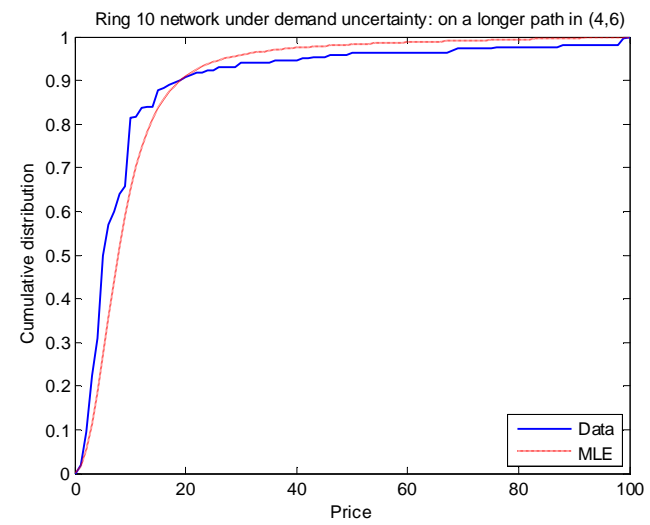
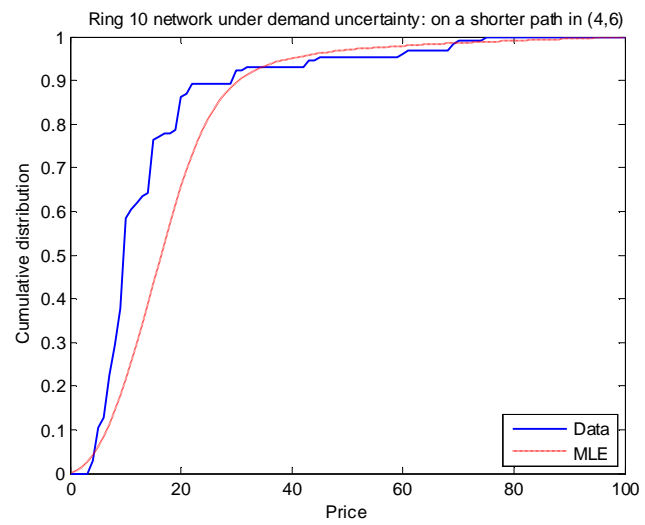
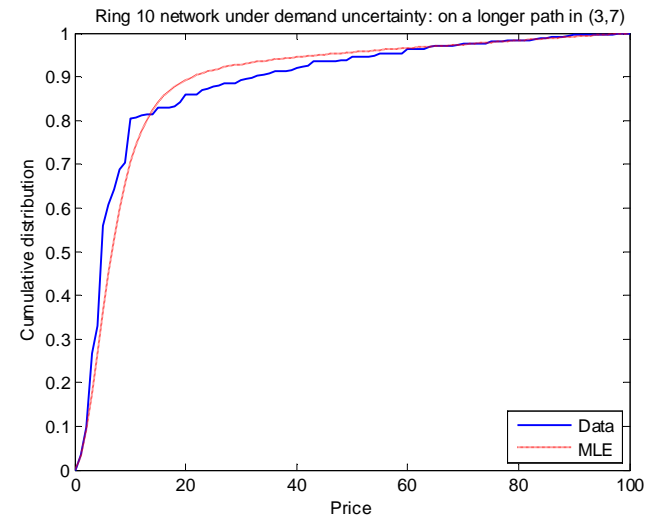
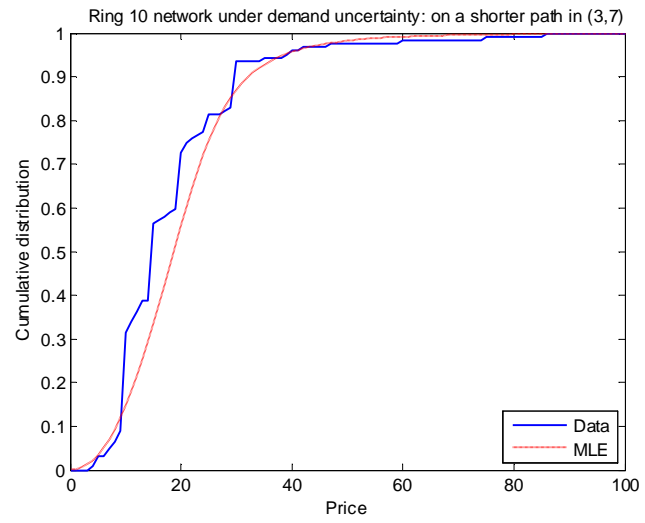
Online Appendix II

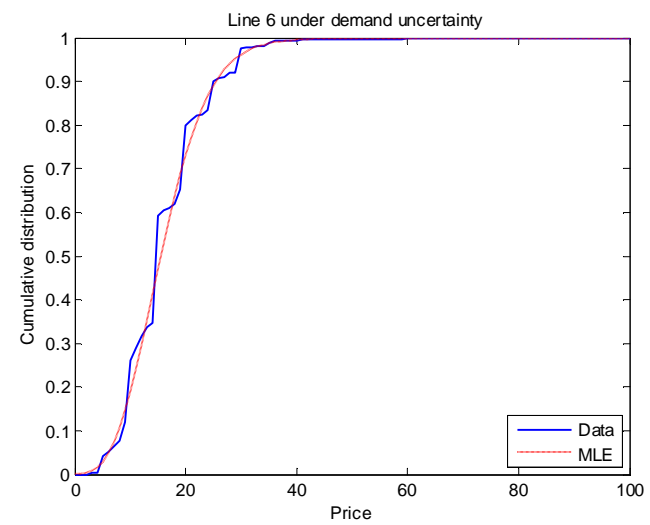
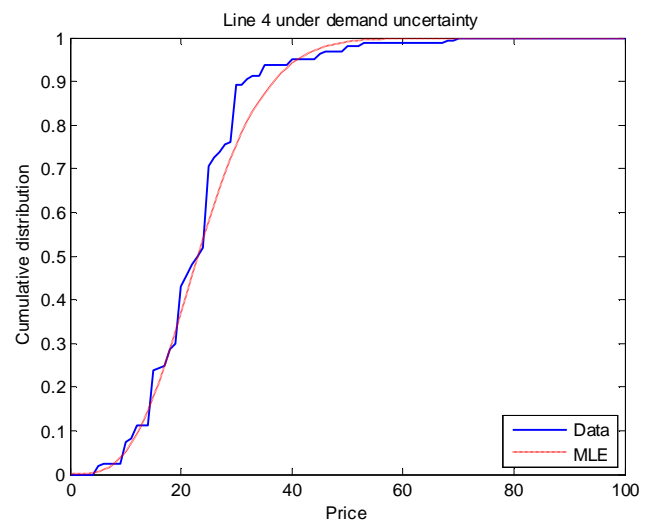
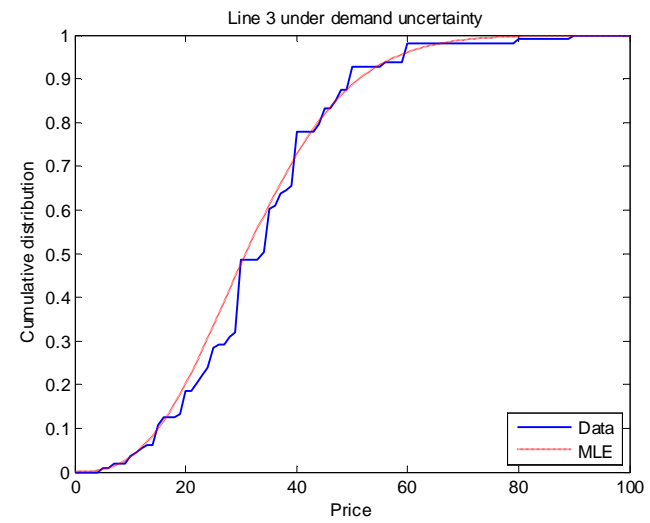
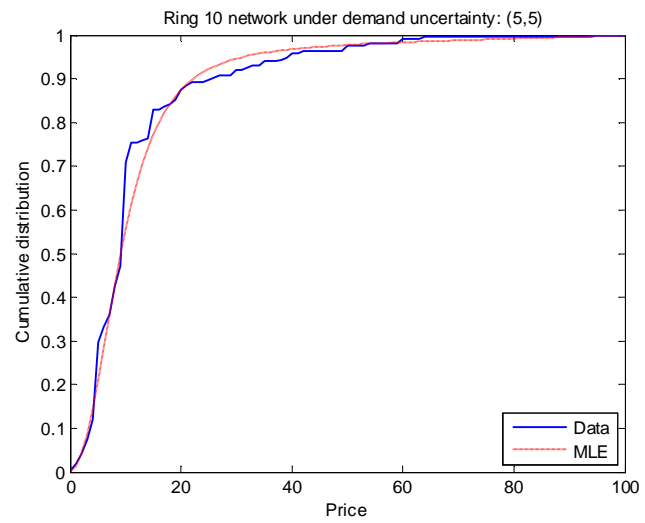
Comparisons of cumulative distributions of prices of the data and the estimated model of strategic uncertainty

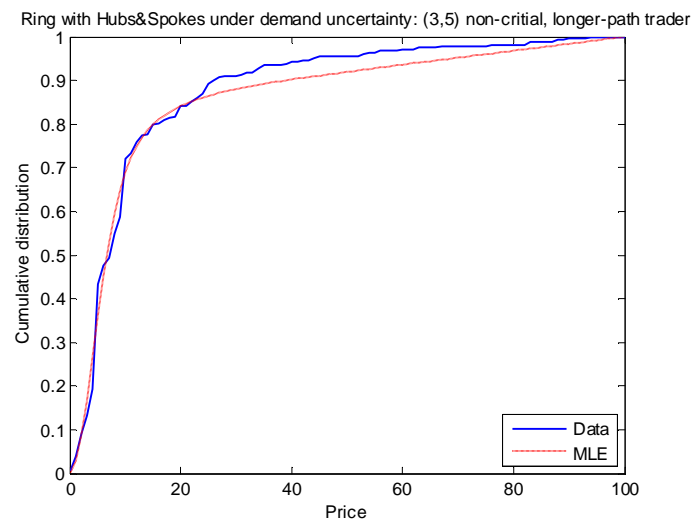
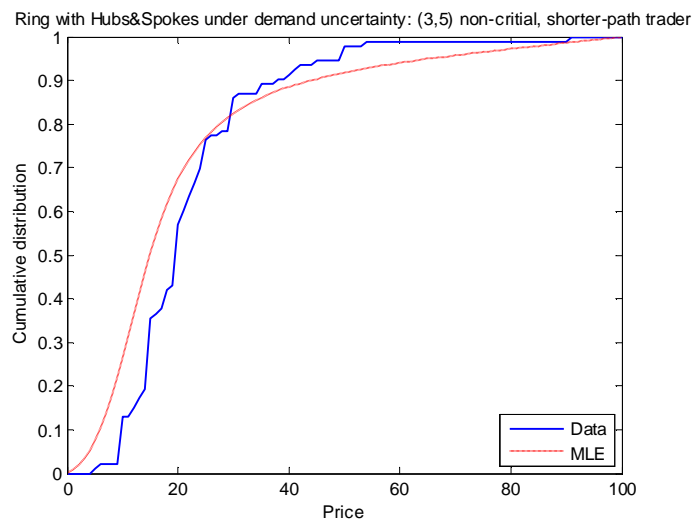
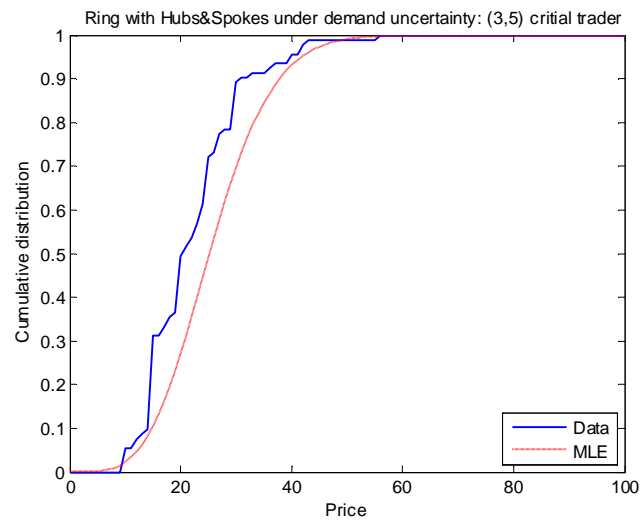
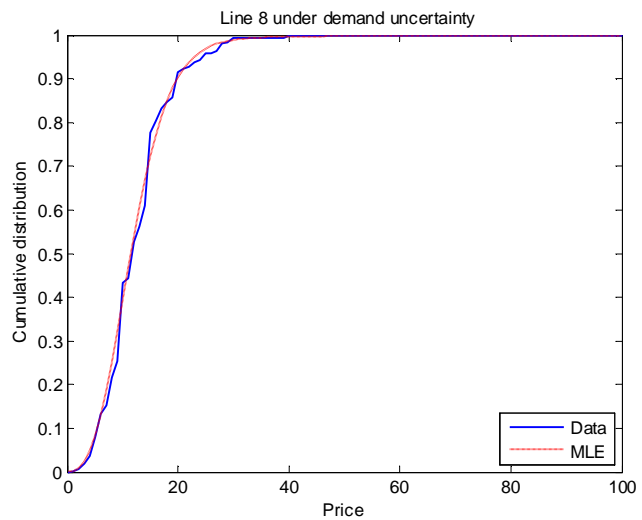
1. Experiment with demand uncertainty

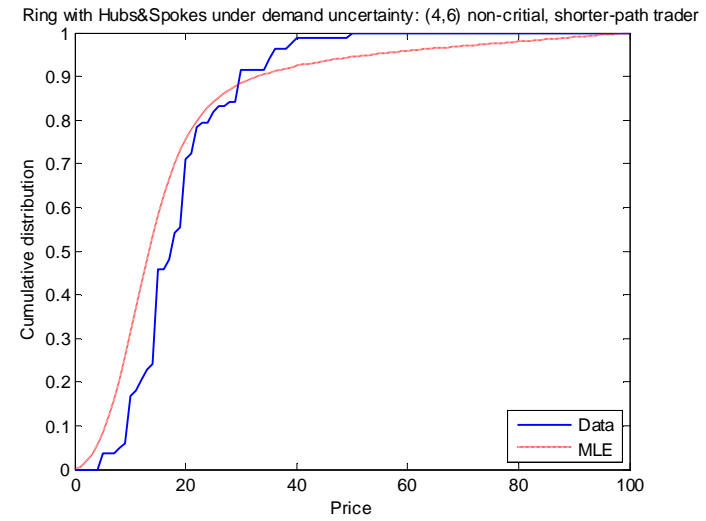
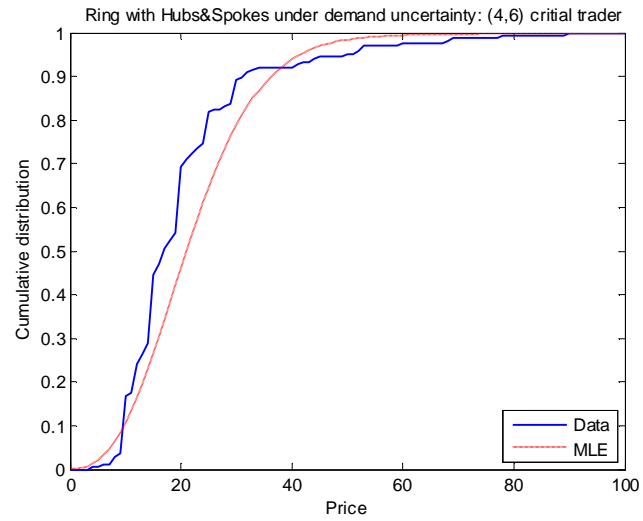
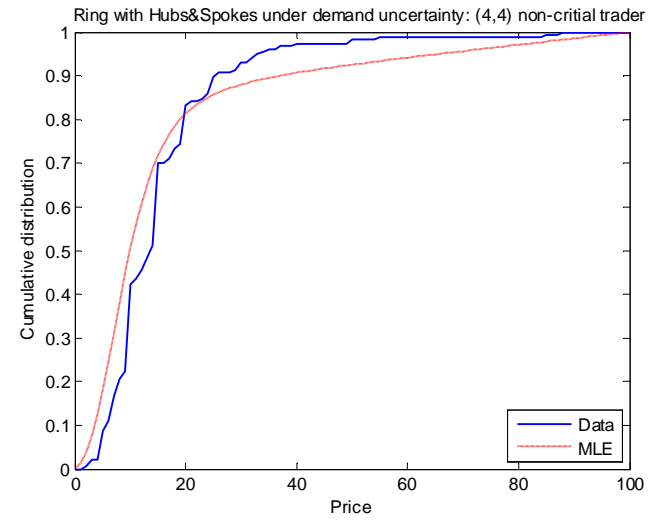
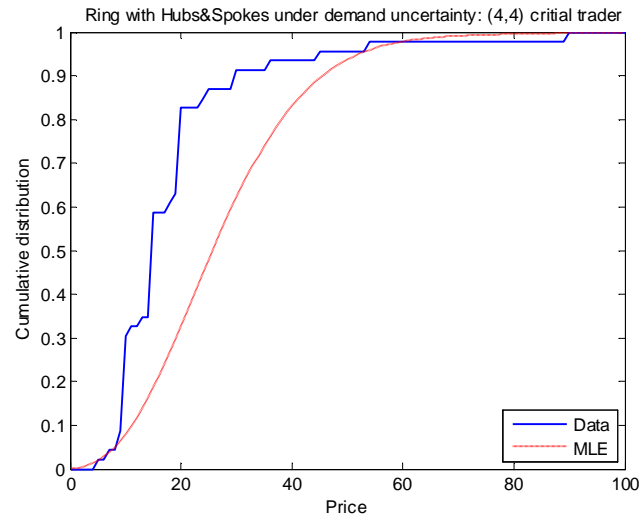




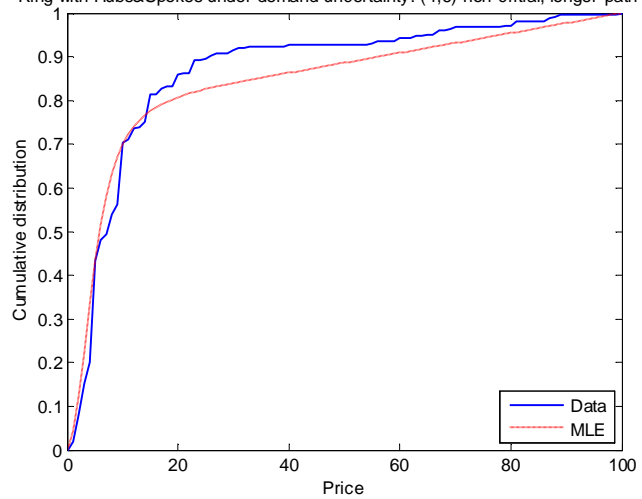




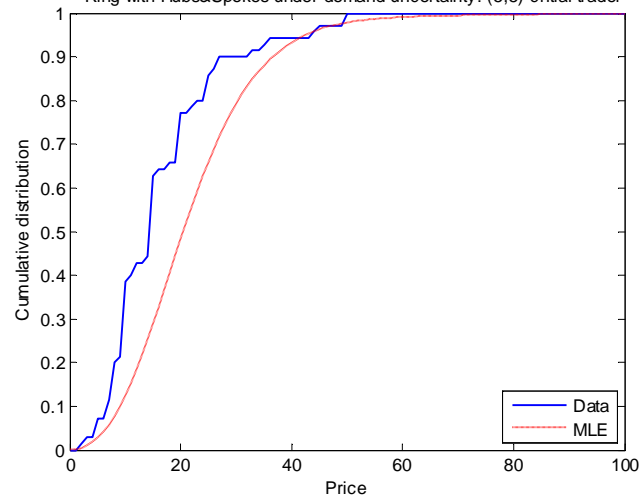




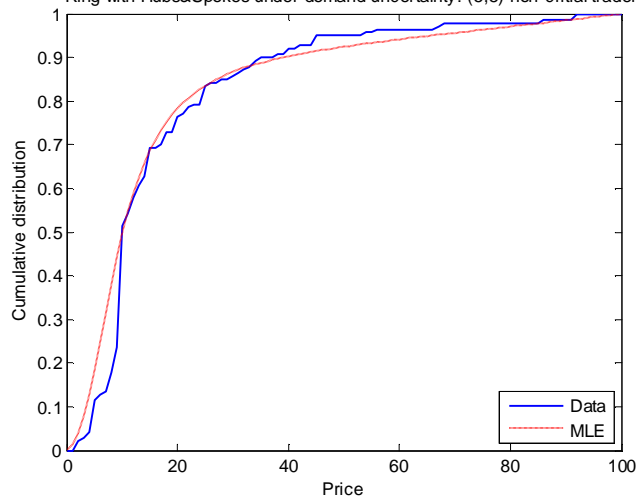
Ring with Hubs&Spokes under demand uncertainty: (4,6) non-critical, longer-path trader



Ring with Hubs&Spokes under demand uncertainty: (5,5) critical trader



Ring with Hubs&Spokes under demand uncertainty: (5,5) non-critical trader



2. Benchmark Experiment

