Background text on Pitgame by Yvan Lengwiler, University of Basel

How does a well-organised market function?

In Pitgame, players who have little private information interact and 'discover' an allocation and an approximate market-clearing price, without a central coordinating institution driving the process. This process, which Adam Smith called 'the invisible hand' and which the players experience during the game, needs careful explanation.

1. Supply and demand curves

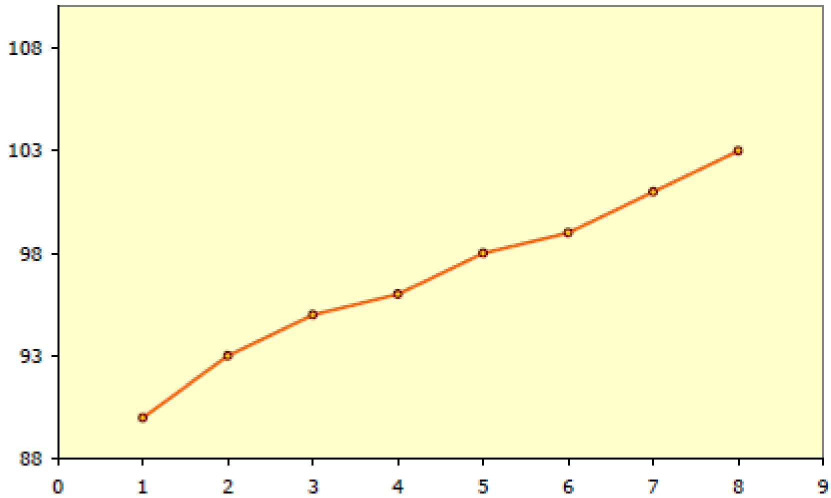
The supply and demand curves are a representation of all the order cards in the game. We use a concrete example to explain this important representation.

Reservation prices...	
... Seller	... Buyer
96	90
97	93
99	95
100	96
100	98
103	99
105	101
108	103

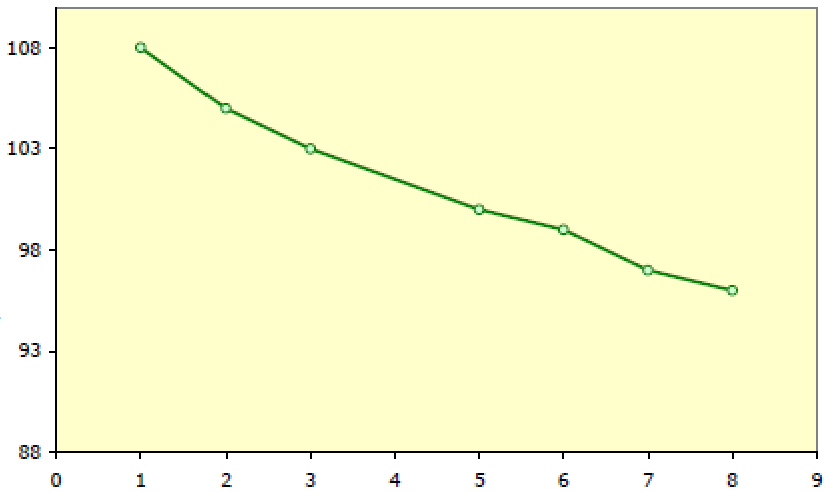
Let's assume that there are 16 players. The table shows the reservation prices for all the order cards, which are distributed among the players.

How many sellers would be prepared to sell at a price of 100? Six sellers: those with reservation prices of 90, 93, 95, 96, 98 and 99. How many would still be prepared to sell if the price fell to 97? In this case, four sellers would still be prepared to trade (those with reservation prices of 90, 93, 95 and 96).

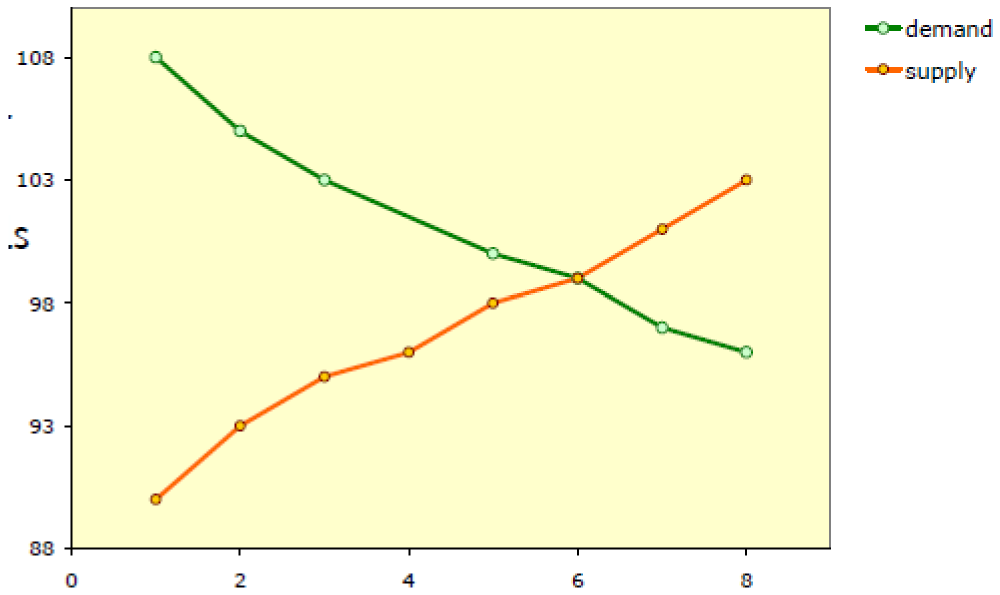
The supply curve represents the maximum amount offered for sale, depending on the price. Thus, to plot the curve we need to list the sellers' reservation prices in ascending order (right-hand column of table), and to enter the number of sellers prepared to sell for each price between 90 and 103. The results are shown in the chart on the right, which represents all the sellers' order cards distributed among the players.



The demand curve is constructed in the same way. It answers the question of how many buyers would be prepared to buy at each different price. Thus, to construct this curve we need, in turn, to plot the buyers' reservation prices sequentially, only this time we start with the highest reservation price and work through the list until we have processed all the buyers' order cards (see chart on the right).



We can now transfer both curves to a single chart, thereby obtaining a plot of both buyers' and sellers' reservation prices in the game (i.e. in the market). The point at which the curves intersect is particularly significant. This is the price at which the number of sellers prepared to sell and the number of buyers prepared to buy are exactly the same. For this reason, economists call this point the *market equilibrium*. In our example, a price of 99 represents the market equilibrium. At this price, six sellers and six buyers are willing to trade.



2 Efficiency

A player engaging in a trade usually achieves a profit. He/she never needs to worry about a loss, since nobody is forced to carry out a trade. Let's look at our example. It is conceivable that the seller with the lowest reservation price (90) and the buyer with the lowest reservation price (96) meet and agree to trade. Since the buyer is prepared to pay 96 at most, and the seller wants at least 90, they will be able to settle on a mutually acceptable price somewhere in between.

The same thing could happen with the next pair. They would agree on a price between 93 and 97. In fact, it is conceivable that, at the end of the game, all 16 players will have carried out a trade. How much profit each makes depends on the price agreed by each set of trading partners. Therefore, these prices influence only the distribution of the profit, but not the total amount of profit achieved. Here, the total profit from all transactions would be 33 (see table). The trades described above maximise the amount exchanged. But is there perhaps another sequence of trades that would lead to a higher profit overall?

Reservation prices...		Trading
... Seller	... Buyer	profit
96	90	6
97	93	4
99	95	4
100	96	4
100	98	2
103	99	4
105	101	4
108	103	5
	Total:	33

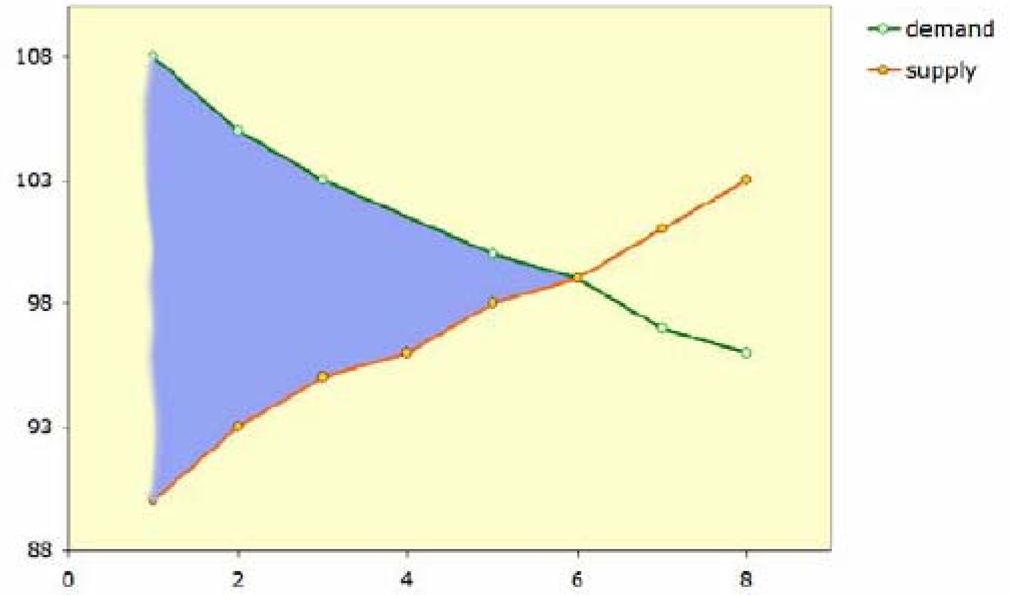
We could, for example, investigate what happens if the buyer with the highest reservation price (108) is paired with the seller with the lowest reservation price (90). They will agree on a price between 90 and 108. The next pair will agree on a price between 93 and 105, and so on, until the sixth pair. In this pair, both sides have a reservation price of 99, so they will not trade or, if they do, then only at a price of 99. In any case, they will not make any profit. The remaining two sets of buyers and sellers in this sequence will not trade and will leave the market without doing any business.

Reservation prices...		Trading
... Seller	... Buyer	profit
108	90	18
105	93	12
103	95	8
100	96	4
100	98	2
99	99	0
97	101	---
96	103	---
	Total:	**44**

So, in this situation, the amount traded is smaller (only six units instead of eight), but the total profit achieved is higher, namely 44 instead of 33 as in the previous sequence. In fact, no other combination of pairs produces a higher total profit. But there are other combinations that achieve the same total profit; one example is shown on the right. The only important point is who manages to trade and who does not. So long as only those buyers can trade whose reservation price is higher than (or equal to) the equilibrium market price of 99, and only those sellers can trade whose reservation price is lower than (or equal to) the equilibrium price, then the total achieved profit will always be 44. The question of who is trading with whom in the two groups is irrelevant. This kind of situation – in which the total profits are maximised – is known by economists as being *efficient*.

Reservation prices...		Trading
... Seller	... Buyer	profit
103	90	13
100	93	7
108	95	13
100	96	4
105	98	7
99	99	0
97	101	---
96	103	---
	Total:	**44**

The chart below shows why it is precisely this combination of buyers and sellers that maximises the total profit. It is the buyers and sellers to the left of the market equilibrium who should be able to trade. The blue-shaded area shows the difference between the buyers' and sellers' reservation prices, and hence the total profit that can be achieved. This blue area is maximised if six units are sold as described. If a player to the right of the market equilibrium also manages to trade, or if a player to the left of the equilibrium is unable to trade, the achieved profit will automatically be lower.

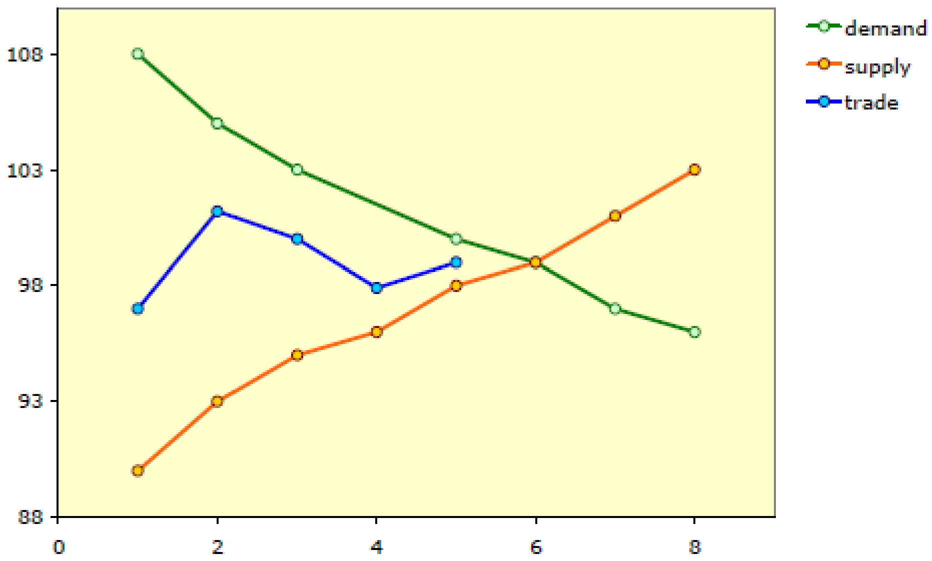


3 Theoretical forecast

Economic theory thus predicts that the point of intersection between the supply and demand curves will approximately describe market participants' behaviour. In essence, this means that:

- the market price will move towards the equilibrium price (99 in our example);
- the amount traded will also correspond to the equilibrium point (six units in our example);
- the sum of the achieved profit is maximised (44 in our example), and hence the market is efficient.

Now we can proceed to evaluate the games played. To what extent do the theoretical forecasts coincide with actual behaviour? How great is the divergence? Does the divergence get smaller in later rounds of the game, i.e. do the players get used to the mechanics of the market?



108
103
98
93
88
0
2
4
6
8
demand
supply
trade