

# Master PEI: Game Theory in Banking, Finance and the International Arena

## Chapter 2: Additional Exercises and Problems

Jérôme MATHIS

### Problem 1: Cyprus: Taxation of bank deposits to avoid a euro exit

Summer 2012, Cyprus asked the European Union to provide help for the crisis-hit country. Affected by the Greek haircut, Cypriot banks called for the government aid after having lost 4.2 billion euros (24% of Cyprus GDP) due to a large amount of Greek sovereign bond holdings. Dragged into the Greek crisis, Cyprus may be unable to pay the loan repayments if an agreement on a rescue plan is not achieved in the coming weeks with the so-called *troika* comprised of the European Commission (EC), the European Central Bank (ECB) and the International Monetary Fund (IMF). Before contributing the troika suggests that the Cypriot government implement austerity measures to restore the fiscal balance. In late February 2013, the Managing Director of the European Stability Mechanism considers that Cyprus presents a systemic risk to the entire euro zone and that decisions must be made quickly to avoid contagion. March 2013, the issue of bailout arises more than ever.

We would like to study the three following games, using the following information – labeled from  $(I_1)$  to  $(I_9)$ .

$(I_1)$  A Cyprus euro exit would be the worst outcome for all stakeholders.

$(I_2)$  Although all stakeholders wish rescue, everyone wants to be involved as little as possible.

$(I_3)$  Cyprus rescue over the period 2012-2016 requires a help estimated at 17 billion euros (equivalent to Cyprus annual GDP).

$(I_4)$  If the Cypriot government grants an extra effort, it has the possibility of a windfall tax on domestic bank deposits to raise 7 billion euros. Two possible forms of taxations are considered: the first one, denoted by  $T_1$ , is a tax of 6.75% on all bank deposits in the country below 100,000 euros, and a tax of 9.9% on those above that threshold; the second one, denoted by  $T_2$ , is to tax only bank deposits above 100,000 euros, which suffer losses up to 30%. The total amount collected is the same under both taxation schemes.

$(I_5)$  In the case of extra effort, the Cypriot government would favor the second tax which is more popular as small depositors are exempted.

$(I_6)$  If the EU, IMF and ECB agree to help Cyprus, they have the option to lend either 10 or 17 billion euros.

In what follows, motivate your answers by indicating, if any, what information  $(I_k)$ ,  $k \geq 1$  to use.

1. Label the three possible Cyprus actions and the three possible troika's (EU, ECB and IMF) actions.
2. Depict the sequential form game played by Cyprus and the troika where Cyprus moves first. Rather than specifying any payoffs denote the nine leaves (terminal node) of the game tree by  $f_1, f_2, \dots, f_9$ .

3. Which leaves correspond to a rescue of Cyprus?
4. Within each subgame following a Cyprus action, identify troika's preferred leaves.
5. Among the three preceding troika's preferred leaves, identify Cyprus preferred leaf.
6. Find the backward induction outcome.

(*I*<sub>7</sub>) Cyprus is the leading destination for Russian capital abroad. Ratings agency Moody's estimated Russian businesses and individuals hold 30 billion euros in deposits on the island. Although the Cypriot authorities deny it, the island is considered a tax haven. Concerned about the fate of his rich fellow exiles, Russia disapproves any taxation of bank deposits above € 100,000. In February 2013, Russia is willing to offer, subject to the Cyprus' commitment to not raise any tax, financial assistance in exchange for licensing production of natural gas off the island. However, the Russian finance minister warns that these measures will not save Cyprus, and that a recovery will require a European Union assistance. We assume that financial aid from Russia would consist in 7 billion euros. Russia prefers not to provide any assistance that would not yield to a rescue.

(*I*<sub>8</sub>) In March 2013, the eurozone and the IMF report that their bailout would be a maximum of 10 billion euros. This reduction of the potential bailout from 17 to 10 billion euros has been decided to not increase the public debt.

7. Now, what are the possible troika's actions? What are the possible Russia's actions?
8. Depict the sequential form game played by Russia, Cyprus and the troika where Russia moves first and Cyprus moves second. Indicate the corresponding total amount of money collected at each of the eight leaves of the game tree.
9. Find the backward induction outcome.
10. Does the troika prefer this equilibrium to the one of question **6** ?

(*I*<sub>9</sub>) The Chancellor of Germany does not like Moscow's proposal, which would put Cyprus in the orbit of a foreign state to the European Union. She urges the Cypriot President that negotiations on the bailout plan are carried out with the troika only. Cyprus has to choose between Russian and troika assistance but cannot benefit from both altogether.

11. Depict the new game tree in the sequential order of question **8**.
12. Find the backward induction outcome.
13. Does the troika prefer this equilibrium to the one of question **6** and **10**?
14. Provide a conclusion on the optimal troika's strategy.

## Problem 2: Italian Banks struggling with a burden of bad debt and loans.

At the end of 2016, the third-largest economy in the Euro zone, Italy, is in bad shape. Two decades of dismal economic performance has increased the chances of businesses getting into difficulty and being unable to maintain their loan payments. As a result, Italian banks are weighed down with a massive problem of bad debts, or non-performing loans, in the amount of €360bn - equivalent to about one-fifth of the country's economy. The purpose of this exercise is to study the various ways banks can deal with these problem loans.

Let  $B$  denote a representative Italian bank.  $B$ 's current assets is reflected by its stock market price, denoted as  $S$ , which reflects the value of a stockholder's share.

### Part A. $B$ is the only player and has only two possible actions.

Assume  $B$  has two possible actions: either to sell its assets to investors or to conduct business as usual. Selling to investors involves a discount due to delays in the foreclosure procedures that enable creditors to recover their money. This discount is denoted as  $d \in [0, 1]$ , and the new share value is  $(1 - d) \times S$ . If  $B$  chooses to conduct business as usual, there exists two mutually exclusive consequences: either the bank partially recovers (with probability  $p \in [0, 1]$ ) the amount of its loans; or the bank goes bankrupt (with probability  $(1 - p)$ ). Partial recovery (resp. bankruptcy) yields a new share value of  $0.9 \times S$  (resp. zero).

1. Depict the corresponding game tree.
2. Assume  $p = 0.7$  and  $d = 25\%$ . What is  $B$ 's optimal strategy?
3. Give  $B$ 's optimal strategy depending on the value of the parameters  $p$  and  $d$ . Characterize the threshold on  $p$  below which  $B$  prefers to sell.

### Part B. $B$ is not the only player and has more than two possible actions.

Suppose that, in addition,  $B$  has a third possible initial action that consists in raising capital from financial markets. By doing so,  $B$  is posting a take-it-or-leave-it offer for issuing additional shares. This process will decrease each share value by 20% (i.e., the new per share value is  $0.8 \times S$ ). The likelihood that the offer will be accepted is 60%. If  $B$  fails to raise capital (i.e., financial markets reject the offer) then  $B$  has the possibility to proceed as in Part A above (we assume  $p = 0.7$  and  $d = 25\%$ ) or to ask the Italian government to bail the bank out. The Italian government, denoted as  $G$ , can either accept or reject this alternative. An Italian bail-out is subject to European legislation. European Union rules, agreed upon by the member states in the wake of the previous financial crisis, require that a bank's creditors, in particular its bondholders, take losses before the taxpayer shoulders the cost. So, if the Italian government accepts to bail-out the bank, the European Union, denoted as  $EU$ , can nonetheless decide to oppose the bail-out. Opposition by the European Union may infuriate the Italian citizens. An Italian political party having anti-Euro policies could then step in to win the next elections. The likelihood of an exit from the Euro-zone is 50%. We assume all players to be risk-neutral.

( $I_1$ ) An Italian bail-out is damaging to the  $EU$ 's credibility to implement its legislation.  $EU$ 's associated payoff is  $-1$ .

( $I_2$ ) Any exit from the Euro-zone would be very detrimental to  $EU$  and has an associated payoff of  $-3$ .

( $I_3$ )  $EU$ 's opposition to the Italian bail-out followed by Italy remaining in the Euro-zone has an  $EU$ 's associated payoff of 0.

( $I_4$ )  $B$ 's debt is owned, to a large extent, by Italian citizens, so the Italian government will always accept to bail  $B$  out.

( $I_5$ ) The bail-out decreases  $B$ 's per share value by 30%.

( $I_6$ ) If  $B$  chooses to conduct business as usual after a market rejection to its issuance of additional shares, the probability of a partial recovery falls to 40%.

( $I_7$ ) If  $B$  chooses to sell after a market rejection to its issuance of additional shares, the discount rises to 40%.

In what follows, specify the information ( $I_k$ ),  $k = 1, 2, \dots, 7$ , that allows you to answer the question.

1. Depict the corresponding game tree without the payoffs.
2. What is  $EU$ 's optimal strategy?
3. What is  $G$ 's optimal behavior?
4. What is  $B$ 's optimal behavior following a financial market rejection of its issuance of additional shares?
5. What is the subgame perfect Nash equilibrium of the whole game? Describe all players optimal strategies.
6. Depict the whole game tree with the payoffs and your solution path.

### Problem 3: Paris and Frankfurt compete to woo Britain's banks post-Brexit.

*We take up here the problem exposed in Chapter 1 (Parts A and B).*

#### Part C. City banks.

We are back to Part A where there is no intervention from the European Commission.

All banks do not have the same preferences. Some of them have a financial activity that requires them to maintain a staff composed of the most talented bankers. This requires a flexible hiring-and-firing regime. Most of these employees enjoy living in a cosmopolitan city such as London or Paris. Other banks prefer to be close to the European Central Bank, situated in Frankfurt, and are susceptible to be influenced by the cost of renting office space which is lower in Germany.

To simplify the analysis, we assume there are two groups of banks. The first group is composed of banks who will select Paris, unless the hiring-and-firing regime is less flexible than Frankfurt. The second group is composed of banks who will select Frankfurt unless the tax cut is lower than in Paris. The cities' payoff associated in attracting the first (resp. second) group is denoted as  $B_1$  (resp.  $B_2$ ). For instance, when Paris and Frankfurt both play  $(H, F)$ , their respective payoff is  $B_1 - c_H$  and  $B_2 - c_H$ . We assume  $\min\{B_1, B_2\} > c_H$

- C1. Depict the game tree where Paris plays first and Frankfurt moves second.
- C2. What are the payoffs associated with the set of the subgame perfect Nash equilibria?