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Abstract

In the present work, we propose a coopetitive model applied to the Greek crisis, which aims both at improving the competitiveness of the Greek productive system and rebalancing the current account balance of the country. Our model of coopetition (based on normal form game theory) is conceived at a macro level, wherein there are two players: Greece and SNC (the Surplus Northern Countries of the euro area). We suggest a model that looks for a win-win solution. The win-win solution entails a cooperative bi-strategy in which SNC should contribute to re-balance its trade surplus with respect to Greece and, in addition, SNC should provide a certain amount of foreign direct investment (FDI) to improve the competitiveness and the growth in Greece. Thus we find a transferable utility and properly coopetitive solution, convenient for all the players.

Keywords. Games and economics; competition; cooperation; coopetition

1 Introduction

How can we help Greece to find solutions to overcome or, at least, improve its economy which is still suffering from a deep crisis since 2010? Which kind of policy actions can be taken within the euro system to make the Greek economy more competitive and steer the country towards a path of sustainable economic growth? The austerity measures imposed by the European authorities and the IMF to Greece revealed their limits, determining a long and deep recession and making the recovery very problematic, as Mussa (2010) had already foreseen. In the present work we propose a coopetitive model applied to the Greek crisis, which aims both at rebalancing the current account balance of the country and make the Greek productive system more competitive. So, we propose a model that looks for a win-win solution. This model, based on normal form game theory and conceived at a macro level, aims at suggesting feasible solutions in a coopetitive perspective for the divergent interests, which drive the economic policies of the countries in the euro area. In the model we consider only two players: Greece and the Northern Countries of the euro area in surplus (SNC), namely: Germany, Austria, France, Finland, Netherlands and Luxembourg. In fact, since 2008, these latter countries have become much more competitive than the Southern countries of the euro area (Greece, Portugal, Spain and Italy), thus these Northern countries have obtained large current account surpluses. In our model the win-win solution entails that SNC should contribute to re-balance its trade surplus with respect to Greece. In addition SNC should provide a certain amount of foreign direct investment (FDI) that can improve the competitiveness of Greek economy, FDI may also become an important part of a new strategy of growth in Greece because of its spillover effects. This economic policy strategy based on coopetition pursued by SNC and Greece is convenient for both since it will help to make the euro area a financially stable region; in addition the improved competitiveness of Greece will favor its growth and this will benefit SNC as well. We are indeed aware that this model is built on some special assumptions, though not unrealistic, so our analytical framework of coopetition represents a partial and possible way out of the economic crisis that hits the Greek economy.

2 Greece, its crisis and the strategy based on coopetition.

Greece is still suffering a deep and lasting economic crisis. The rates of changes of its real GDP in the last three years, 2011, 2012, 2013, have been heavily negative, respectively -7.1 per cent, -6.4 per cent, - 4.2 per cent (Eurostat, 2013). All this demonstrates that the austerity policies imposed by the European authorities and the IMF have produced a severe and lasting downturn in the economy (Cline, 2013). So the only desiderable and correct solution for Greece is to favour its growth (De Grauwe, 2013, Schilirò, 2013). Carf and Schilir have already suggested a strategy based on coopetition to find feasible solutions to overcome the Greek crisis (Carf, Schilir, 2011). Like in the other coopetitive models we have developed (Carfi, Schilirò 2011, Carfi, Schilirò, 2012), also in the present model we provide a coopetitive win-win solution, a situation in which each agent (the Greece, on one side, and the SNC, on the other) cooperate and compete at the same time, taking into account the divergent interests of the two sides, and in which both sides gain. In this paper, more specifically, we propose a coopetitive model where the coopetitive (shared) variables are the exports of goods and services from Greece to SNC of the euro area in surplus (SNC) and the FDI from SNC to Greece. Regarding the exports of Greece towards SNC, this strategy can alleviate the trade deficit of the Greek economy. As far as the latter variable (FDI), Greece, by receiving inward investment, will improve its competitiveness and gain in terms of an increase in productive capacity, determined by a shift in the aggregate supply. The Greek economy will also experience an increase in the aggregate demand, with a greater production and the creation of new jobs. A very important effect of FDI is that home producers in Greece will have access to the latest technology from abroad with positive externalities on the production system; moreover there will be a positive effect on the countrys capital account, since FDI represents an inflow (credit) on the capital account. Finally, there will be less need to import because goods are produced in the domestic economy. All this will concur to affect positively the competitiveness of the Greek economy, favoring the stability and growth in Greece and, in turn, benefiting the whole euro area. The present model is based on the notion of coopetition (Branderburger, Nalebuff, 1995, 1996; Bengtsson, Kock, 2000; Luo, 2007; Padula, Dagnino, 2007), it provides a game theory framework that offers a set of possible solutions in a coopetitive context allowing us to find bargaining Pareto solutions in a win-win scenario. We already devised a coopetitive model at a macroeconomic level in which we had developed a coopetitive game by excluding the mutual influence of the actions (or strategies) for the two players (Carfi, Schilirò, 2011). This choice has allowed us to greatly simplify the model, secondly it has highlighted the coopetitive aspect, although at the expense of the classical feature of game theory. Later we developed other models (Carf, Schilirò, 2012a, 2013) where we have taken into account of this mutual influence, as in the present model we are going to describe.

3 The coopetitive model

In this paper, we develop and apply the new mathematical model of a *coopetitive game* - introduced in Game Theory for the first time by David Carfi and already adopted by David Carfi and Schilirò in [18, 19, 20, 21] in different contexts. The model introduced in this paper requires technics and competences adopted and pointed out in [6, 7, 8, 9, 10, 11, 12, 13, 14] and, from a algorithmic point of view, in [1, 15, 16, 17]. We desire to notice that, until now, the Brandenburgher and Nalebuff idea of coopetitive game was used, in a mostly intuitive and non-formalized way, in Strategic Management Studies. Let us begin with our basic assumptions.

Assumption 1. Our first hypothesis is that SNC must stimulate the aggregate demand to re-balance their trade surplus in favor of Greece. Moreover, we assume that - in agreement with the Greek Government - they will invest in innovative and efficient technologies in Greece.

Assumption 2. The second hypothesis is that Greece, a country with a huge public debt, unsustainable to deficit/GDP and low productivity is forced by external authorities to undertake austerity measures and, since the country needs to get the equilibrium of its trade balance, it agrees to increase its exports primarily towards *SNC*.

Assumption 3. The coopetitive model we propose hereunder must be interpreted as a normative model, in the sense that:

• *it imposes some clear and a priori conditions to be respected, by binding contracts, in order to enlarge the possible outcomes of both countries;*

• *consequently, it shows appropriate win-win strategy solutions, chosen by considering both competitive and cooperative behaviors, simultaneously;*

• *finally, it proposes appropriate fair divisions of the win-win payoff solutions.*

Assumption 4. The strategy spaces of the model are:

• the strategy set of SNC, say E, set of all possible consumptions of SNC (in our model), given in a conventional monetary unit.

• the strategy set of Greece F, set of all possible reductions of public expenses of Greece (in our model), given in a conventional monetary unit (different from the above SNC monetary unit);

• a shared strategy set C, whose elements are determined together by the two players, when they determine their own respective strategy sets E and F, SNC and Greece. Every strategy z in C is a pair (z_1, z_2) of monetary amounts: the first component z_1 represents an amount - given in a third conventional monetary unit - of Greek exports imported into SNC, by respecting a binding contract; the second component z_2 represents the amount of investments of SNC in Greece, by respecting a binding ex-ante agreement.

Therefore, in the model, we assume that SNC and Greece define the set of coopetitive strategies.

3.1 Strategy spaces and payoff functions

Assumption 5. In this model, we consider a linear affine mutual interaction between SNC and Greece, adherent to the real state of the Euro-area. Specifically:

• we consider an interaction between the two players also *at the level of their non-cooperative strategies*;

• we assume that *Greece also should import (by contract) some SNC production.*

Assumption 6. We assume that:

• any real number x, belonging to the interval $E := [0, 3]$, represents a possible consumption of SNC (given in an appropriate conventional monetary unit);

• any real number y, in the same interval $F := E$, represents aggregate austerity measures of Greece (given in another appropriate conventional monetary unit);

• any real number z_1, again in the interval $C_1 = [0, 2]$, represents any possible amount of Greek exports which is imported by SNC (given in conventional monetary unit), by a binding ex ante agreement;

• any real number z_2, in the same interval $C_2 = [0, 2]$, represents a possible investment of SNC (given in another appropriate conventional monetary unit).

3.1.1 Payoff function of SNC

We assume that the payoff function of SNC, f_1, is represented by its *aggregate demand*:

• f_1 is equal to the consumption function C_1 plus the investment function I_1 plus government spending (that we shall assume equal 2, constant in our interaction) plus export function X_1 minus the import function M_1, that is

$$f_1 = 2 + C_1 + I_1 + X_1 - M_1.$$

We assume that:

• SNC's consumption function C_1 is the first projection of the strategic coopetitive space $S := E^2 \times C$, that is defined by

$$C_1(x, y, z) = x,$$

for every possible SNC consumption x in E; this because we assumed SNC's consumption to be the first strategic component of strategy profiles in S;

• the investment function I_1 is constant on the space S, and by translation we can suppose I_1 equal zero;

• the export function X_1 is defined by

$$X_1(x, y, z) = -y/3 - z_2/2,$$

for every Greek possible austerity measure y and for every SNC possible investment y in innovative technology in Greece; so we assume that the export function X_1 is a strictly decreasing function with respect to the individual Greek strategy and the second cooperative component strategy;

• the import function M_1 is the following partial projection of the strategic space, namely

$$M_1(x, y, z) = z_1,$$

for every cooperative strategy $z_1 \in 2U$, because we assume the import function M_1 depending only upon the cooperative strategy z of the coopetitive game G, our third strategic component of the strategy profiles in S.

Recap. We then assume as payoff function of SNC the aggregate demand f_1, which in our model is equal, at every triple (x, y, z) in the profile strategy set S, to the sum of the strategies x, $-z$ with the export function X_1, viewed as a reaction function to the Greece investments (so that f_1 is the difference of the first and third projection of the strategy profile space S plus the function export function X_1).

Concluding, the payoff function of SNC is the function f_1 of the set S into the real line $\mathbb{R}$, defined by

$$f_1(x, y, z) = 2 + x - y/3 - z_1 - z_2/2,$$

for every triple (x, y, z) in the space S; where the reaction function X_1, defined from the space S into the real line $\mathbb{R}$ by

$$X_1(x, y, z) = -y/3 - z_2/2,$$

for every possible investment y of Greece in the interval $3U$, is the export function of SNC mapping the level y of Greece austerity measure and the level z_2 of Northern investment in Greece into the level $X_1(x, y, z)$ of Northern export.

3.1.2 Payoff function of Greece

We assume that the payoff function of Greece f_2 is again its aggregate demand: consumption C_2 plus investment I_2 plus government spending (assumed to be 1) plus exports X_2 minus imports M_2); so that

$$f_2 = 1 + C_2 + I_2 + X_2 - M_2.$$

We assume that:

• the function C_2 is relevant in our analysis, since we assume the Greek consumptions depend on the choice of the strategy austerity measure y; we assume

$$C_2 = 1 - y/3;$$

• the function $I_2 : S \to \mathbb{R}$ is defined by

$$I_2(x, y, z) = z_2 + nz_1,$$

for every (x, y, z) in S;

• the export function X_2 is the linear function defined by

$$X_2(x, y, z) = z_1 + mz_2,$$

for every (x, y, z) in S (see above for the justification);

• the function M_2 is relevant in our analysis, since we assume the import function, by *coopetitive contract with SNC*, dependent on the choice of the triple (x, y, z) in S, specifically, we assume the import function M_2 defined on the space S by $M_2(x, y, z) := -2x/3$, so, Greece too, must import some Northern product, with value $-2x/3$ for each possible Northern consumption x.

So, the payoff function of Greece is the linear function f_2 of the space S into the real line $\mathbb{R}$, defined by

$$f_2(x, y, z) = 2 - y/3 - 2x/3 + (1 + m)z_2 + (1 + n)z_1,$$

for every triple (x, y, z) in the strategic Cartesian space S.

We note that the function f_2 depends significantly upon the strategies x in E, chosen by SNC, and that f_2 is again a linear function.

Assumption. We shall assume, for our specific study, the factors m and n non-negative and equal respectively (only for sake of simplicity) to 1 and 1/2.

3.1.3 Payoff function of the game

We so have build up a coopetitive gain game with payoff function $f : S \to \mathbb{R}^2$, given by

$$\begin{aligned} f(x, y, z) &= (2 + x - y/3 - z_1 - z_2/2, 2 - y/3 - 2x/3 + (1 + m)z_2 + (1 + n)z_1) = \\ &= (2, 2) + (x - y/3, -2x/3 - y/3) + z_1(-1, 1 + n) + z_2(-1/2, 1 + m), \end{aligned}$$

for every (x, y, z) in $S = [0, 3]^2 \times [0, 2]^2$.

4 Study of the game $G = (f, >)$

Note that, fixed a cooperative strategy z in $(2\mathbb{U})^2$, the section-game $G(z) = (p(z), >)$ - with payoff function $p(z) : E^2 \to \mathbb{R}^2$ defined on the square E^2 by $p(z)(x, y) := f(x, y, z)$, for every bi-strategy (x, y) - is the translation of the game $G(0, 0)$ by the "cooperative" vector

$$v(z) = z_1(-1, 1 + n) + z_2(-1/2, 1 + m),$$

so that, we may study the initial game $G(0, 0)$ and then we can translate the various informations of the game $G(0, 0)$, by the vectors $v(z)$, to obtain the corresponding information for the game $G(z)$ (each game $G(z)$ is isometric to the initial game $G(0)$).

4.1 Study of the initial game G_0

So, let us consider the initial game $G(0)$. The strategy square E^2 of $G(0)$ has vertices 0_2, $3e_1$, 3_2 and $3e_2$, where 0_2 is the origin of the Cartesian plane $\mathbb{R}^2$, e_1 is the first canonical vector $(1, 0)$, 3_2 is the vectors $(3, 3)$ and e_2 is the second canonical vector $(0, 1)$.

4.1.1 Topological Boundary of the payoff space of G_0

In order to determine the the payoff space of the affine game G_0 it suffices to transform the four vertices of the strategy square (the game is an affine invertible game), because the critical zone is empty.

4.1.2 Payoff space of the game $G(0,0)$.

So, the payoff space of the game $G(0,0) = (g, >)$, where the function g is the section $f((\cdot,\cdot),(0,0))$ is the parallelogram with vertices $g(0,0) = (2,2)$, $g(3,0) = (5,0)$, $g(3,3) = (4,-1)$ and $f(0,3) = (1,1)$. As we show in figure 1.

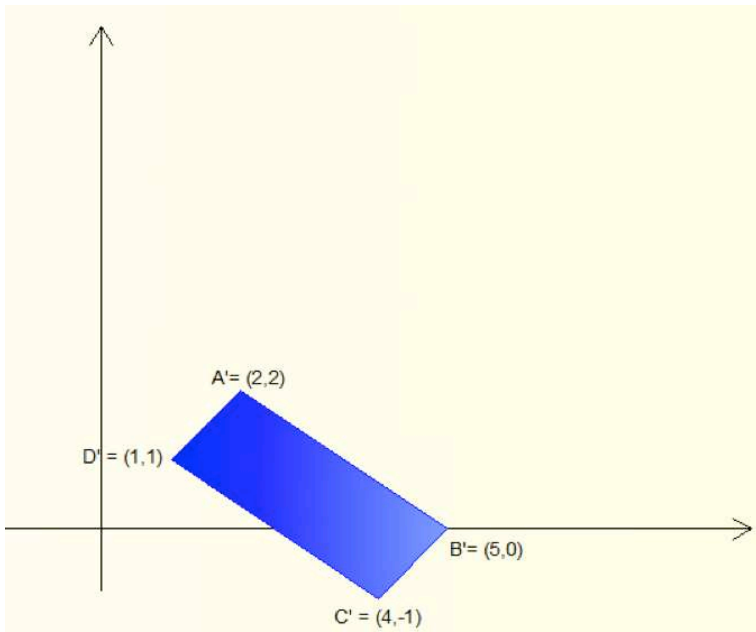

Figure 1: Initial payoff space of the game $(f, <)$.

4.1.3 Nash equilibria.

The unique Nash equilibrium of the initial game is the bistrategy $(3,0)$. Indeed, the function g_1 is linear and increasing with respect to the first argument; analogously, the function g_2 is linear and decreasing with respect to the second argument.

4.2 Study of the entire coopetitive game $G = (f, >)$

4.2.1 The payoff space of the coopetitive game G

The image of the payoff function f, is the union of the family of payoff spaces

$$(\mathrm{im}(p_z))_{z\in C} = (p_z(E \times F))_{z\in C},$$

that is the convex envelope of the union of the initial payoff $p_0(E^2)$ and of its translation by the vectors $v(2,0)$ and $v(0,2)$. The image of the coopetitive payoff function f, that is the payoff space of the game, is the convex envelope of the points $g(0,0)$, $g(3,0)$, $g(3,3)$, $g(0,3)$ and of their translations by $v(2,2)$, as we show in figure 2 (first step) and in figure 3 (second step).

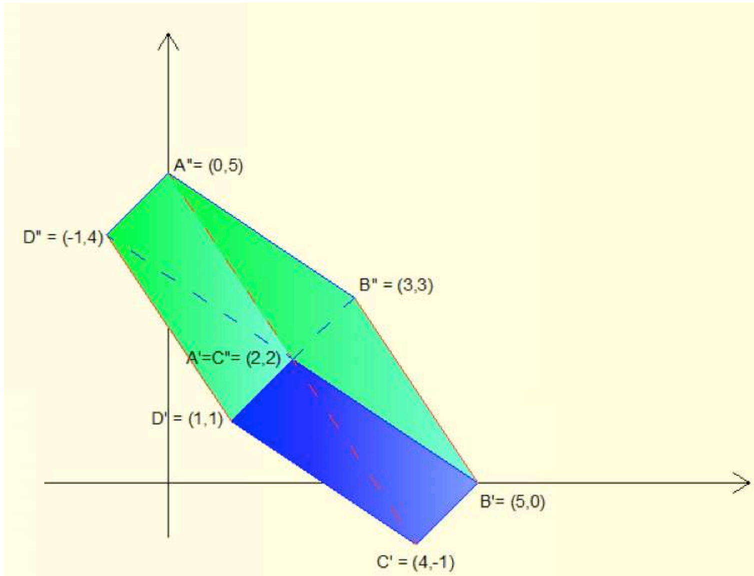

Figure 2: First dilation of the initial payoff space of the game $(f, <)$.

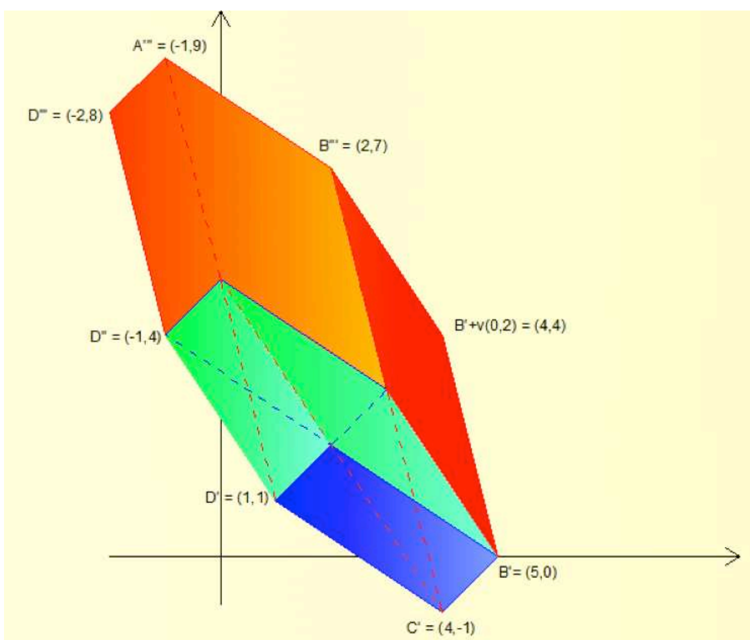

Figure 3: Payoff space of the game $(f, <)$, with $m = 1, n = 1/2$.

4.2.2 Pareto maximal boundary of the payoff space of G

The Pareto sup-boundary of the coopetitive payoff space $f(S)$ is the union of the segments $[A''', B''']$, $[B''', (4,4)]$ and $[(4,4), B']$, see figure 3.

4.3 Possibility of global growth.

It is important to note that the *absolute slopes* of the segments $[B', (4,4)]$, $[(4,4), B''']$, of the Pareto (coopetitive) boundary, are strictly greater than 1. Thus the collective payoff $f_1 + f_2$ of the game is not constant on the Pareto boundary and, therefore, the game implies the possibility of a transferable utility global growth.

4.4 Trivial bargaining solutions.

The Nash bargaining solution on the entire payoff space, with respect to the infimum of the Pareto boundary and the Kalai-Smorodinsky bargaining solution, with respect to the infimum and the supremum of the Pareto boundary, are not acceptable for SNC: they are collectively (i.e., from a Transferable Utility point of view) better than the Nash payoff of the initial game G_0 - both solutions belong to the Pareto segment $[(4,4), (2,7)]$ - but they are disadvantageous for SNC (they suffers a loss, with respect to $(5,0)$): these solutions could be thought as rebalancing solutions, but they are not realistically implementable.

4.5 Transferable utility solutions

In this coopetitive context it is more convenient to adopt a transferable utility solution, indeed:

• the point of maximum collective gain on the whole of the coopetitive payoff space is the point $B''' = (2,7)$.

4.5.1 Rebalancing win-win solution relative to maximum gain for Greece in G.

Thus we propose a rebalancing win-win coopetitive solution relative to maximum gain for Greece in G, as it follows (in the case $m = 1$):

• we consider the portion s, of transferable utility Pareto boundary $M := (2,7) + \mathbb{R}(1,-1)$, obtained by intersecting M itself with the strip determined (spanned by convexifying) by the straight lines $\mathbb{R}e_1$ and $A''' + \mathbb{R}e_1$, *these are the straight lines of Nash gain for Greece in the initial game $G(0)$ and of maximum gain for Greece in G, respectively.*

• we consider the Kalai-Smorodinsky segment s' with vertices $(-1,0)$ - infimum of the Pareto boundary - and the supremum of the Pareto boundary.

• our best payoff rebalancing coopetitive compromise is the unique point K''' in the intersection of segments s and s'.

Figure 4 shows:

• the above Transferable Utility (TU) Kalai-Smorodinsky solution K'''

• the TU Kalai-Smorodinsky solution K'' with respect to the Nash zone.

• the TU Kalai-Smorodinsky solution K' with respect to the Nash extreme point $(4,4)$.

• the TU Kalai-Smorodinsky solution K with respect to the initial Nash equilibrium $(4,4)$.

4.5.2 Win-win solution

The payoff TU Kalai-Smorodinsky solutions K represents a win-win solutions, with respect to the initial Nash gain B'. So that, as we said, *also SNC can increase its initial gain from coopetition.*

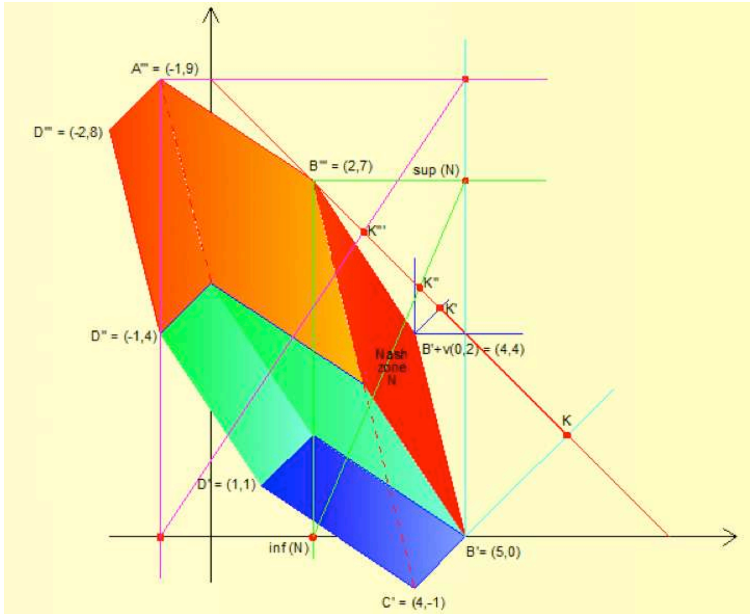

Figure 4: Kalai win-win solutions of the game $(f, <)$.

4.5.3 Win-win strategy procedure.

The win-win payoff K can be obtained in a **properly transferable utility coopetitive fashion**, as it follows:

• 1) the two players agree on the cooperative strategy $(2, 2)$ of the common set C;

• 2) the two players implement their respective Nash strategies in the game $G(2, 2)$, so competing *à la Nash*; the unique Nash equilibrium of the game $G(2, 2)$ is the bistrategy $(3, 3)$;

• 3) finally, they share the "social pie" $(f_1 + f_2)(3, 3, 2, 2)$, in a **transferable utility cooperative fashion** (by binding contract) according to the decomposition K.

5 Conclusions

In conclusion, we desire to stress that:

• the coopetitive game, provided in our contribution, is a *normative model*.

• our sample of coopetition has pointed out one win-win strategy, in a **transferable utility and properly coopetitive perspective**, for Greece and SNC.

In the paper, we propose a framework characterized by a cooperative bi-strategy based on two shared variables, export from Greece to SNC and FDI from SNC to Greece.

Thus, we provide:

• some properly coopetitive solutions (not convenient for SNC): Kalai-Smorodinsky bargaining solution on the *coopetitive Nash path*, set of all possible Nash equilibria of the coopetitive interaction.

• one transferable utility and properly coopetitive solution, convenient also for SNC and also rebalancing for the Euro area.

• an extended Kalai-Smorodinsky method, appropriate to determine rebalancing partitions on the transferable utility Pareto boundary of the coopetitive game.

The solutions offered by our coopetitive model:

• aim at "enlarging the pie and sharing it fairly";

• show win-win and rebalancing outcomes, for the two countries, within a coopetitive game path.

• allow us to find "fair" amounts of Greek exports which SNC must cooperatively import as well as the optimal FDI necessary to improve the Greek economy, contributing to growth and to the stability of both the Greek and SNC economies.

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References

[1] S. Agreste , D. Carfì, A. Ricciardello, 2012, "Algorithms for differentiable parametric games", *APPS* **14**, 1-14.

[2] Bengtsson M., Kock S., 2000. Coopetition in Business Networksto Cooperate and Compete Simultaneously, Industrial Marketing Management, 29(5): 411-426.

[3] Besanko D. and Braeutigam R. (2005), *Microeconomics*, Wiley.

[4] A. M. Brandenburger, B. J. Nalebuff, 1995, "The Right Game: Use Game Theory to Shape Strategy", *Harvard Business Review* **64**, 57-71, July-August.

[5] Brandenburger A. M., Nalebuff B. J.,1996. Coopetition, New York, Currency Doubleday.

[6] Carfì D. (2009), "Payoff space of C^1 Games", *Applied Sciences*, vol. 11, pp. 35-47.

[7] Carfì D. and Musolino F. (2011), "Fair redistribution in financial markets: a game theory complete analysis", *Journal of Advanced Studies in Finance (JASF)* vol. 2, issue 2(4), pp. 74-100.

[8] Carfì D. and Musolino F. (2012), "A coopetitive approach to financial markets stabilization and risk management", in *Advances in Computational Intelligence*, pp. 578-592 (Springer-Verlag); book series: *Comm. in Computer and Information Science*.

[9] Carfì D. and Musolino F. (2012), "Game theory and speculation on government bonds", *Economic Modelling* (Elsevier), 29 (6), pp.2417-2426.

[10] Carfì D. and Musolino F. (2012), "Credit crunch in the Euro area: a coopetitive multi-agent solution", in *Multicriteria and Multiagent Decision Making with Applications to Economic and Social Sciences*, vol. 310, *Studies in Fuzziness and Soft Computing*.

[11] Carfì D. and Musolino F. (2013), "Model of Possible Cooperation in Financial Markets in Presence of Tax on Speculative Transactions", *AAPP|Atti Accad. Pelorit. Pericol. Cl. Sci. Fis. Mat. Nat.*, **91**, 1.

[12] Carfì D. and Musolino F. (2013), "Game Theory Application of Monti's Proposal for European Government Bonds Stabilization", *Applied Sciences*, vol.15.

[13] Carfì D. and Musolino F. (2014), "Speculative and hedging interaction model in oil and U.S. dollar markets with financial transaction taxes", *Economic Modelling*, vol. 37, February 2014, Pages 306-319

[14] D. Carfì, E. Perrone, 2011, "Game Complete Analysis of Bertrand Duopoly", *TPREF*, **2** (1), 5-22, June.

[15] D. Carfì, A. Ricciardello, 2010, "An Algorithm for Payoff Space in C^1-Games", *AAPP* - Atti della Accademia Peloritana dei Pericolanti, Classe di Scienze Fisiche Matematiche e Naturali, **88** (1), 1-19.

[16] D. Carfì, A. Ricciardello, 2012, "Topics in Game Theory", *APPS Monograph*, **9**.

[17] Carfì D., Ricciardello A. (2013), "An Algorithm for Dynamical Games with Fractal-Like Trajectories", *Fractal Geometry and Dynamical Systems in Pure and Applied Mathematics II*, pp. 95-112, *CONM series, vol. 601, AMS*

[18] D. Carfì, D. Schilirò, 2011, "Crisis in the Euro area: coopetitive game solutions as new policy tools", *TPREF*, Theoretical and Practical Research in Economic Fields, **2** (1), pp. 23-36, June.

[19] Carfì D., Schilirò D., 2012. A coopetitive model for the green economy, Economic Modelling, 29(4): 1215-1219.

[20] Carfì D., Schilirò D., 2012a. A framework of competitive games: applications to the Greek crisis, AAPP — Atti della Accademia Peloritana dei Pericolanti, Classe di Scienze Fisiche, Matematiche e Naturali, Vol. 90, No. 1, A1:1-32.

[21] Carfì D., Schilirò D., 2013. A Model of Coopetitive Game and the Greek Crisis, in Pretrosyan L.A., ZenKevich N.A. (eds.), Contributions to Game Theory and Management, vol.VI, St. Petersburg St. Petersburg University, pp.35-62

[22] Cline W. R., 2013. Debt restructuring and economic prospects in Greece, Policy Brief, No. PB 13 3, Peterson Institute for International Economics, February.

[23] De Grauwe, P. 2013. Design failures in the Eurozone: can they be fixed?, LEQS Paper No.57, February.

[24] Luo Y., 2007. A coopetition perspective of global competition, Journal of World Business, 42(2): 129-144, June.

[25] Mussa M., 2010, Beware of Greeks Bearing Debts, Working Paper, Peterson Institute for International Economics, May 17. http://www.piie.com.

[26] Padula G. , Dagnino G. B., 2007. Untangling the rise of co-opetition: The intrusion of competition in a cooperative game structure, International Studies of Management & Organization, Vol.37: 32-52.

[27] A. S. Posen, 2010, "Having a Large Euro Area Is an Advantage for SNC", *Die Welt*, February 19. http://www.piie.com.

[28] D. Schilirò, 2010, "Investing in Knowledge: Knowledge, Human Capital and Institutions for the Long Run Growth", *Governance Of Innovation*, edited by M.J. Arentsen, W. van Rossum, A.E. Steenge, Edward Elgar, Cheltenham, 33-50.

[29] D. Schilirò, 2011, "A new governance for the EMU and the economic policy framework", MPRA paper n. 30237.

[30] Schilirò, D. 2012. A new governance for EMU and the economic policy framework, MPRA Paper 47454, University Library of Munich, Germany: 1-17.

[31] Schilirò, D. 2013. The crisis of euros governance: institutional aspects and policy issues, in R.Mirdala (ed.), Financial Aspects of Recent Trends in the Global Economy, vol.II, Craiova, Asers Publishing: 150-163.