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Exit Risks and Contagion in the Euro Area

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ABSTRACT

THIS PAPER AIMS TO assess the possible impact that the depreciation of a common currency can have on the stability of the related monetary union. It shows that, other things being equal, this depreciation reduces the probability of the weakest Member States leaving the monetary union when hit by a specific and negative demand shock, and the probability of other Member States, which belong to the same area but are not directly hit by any shock, deciding to leave due to the contagion effect. Obviously, the depreciation of the common currency is not the only variable affecting the stability of a monetary area. In this respect, it is sufficient to recall that competition in the international markets is not just price competition. Hence, the paper also analyzes the role played by trade balance elasticities. In our framework, it emerges that higher (lower) elasticities of the weakest countries hit by the specific shock make their exit more (less) likely. Moreover, given the elasticities of these same countries, there is a threshold value in the elasticities of the other Member States under which contagion can never happen.

It is apparent that this framework applies to the possible behavior of 'peripheral' countries in the European Economic and Monetary Union (EMU), and to their interactions with the rest of the area. Hence, this paper can be read as a strategic interaction between two representative countries of the euro area in order to identify the selection mechanisms between good and bad equilibria.

JEL codes: F30, F31, F41, G01.

Keywords: Euro breakup, currency crisis, contagion, Nash equilibria.

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1. INTRODUCTION

The most recent and dramatic episodes of the Greek crisis (end of June – beginning of July 2015) led some of the main European countries and intergovernmental institutions to explicitly discuss the exit of a Member State from the European Economic and Monetary Union (EMU) as a possible way out of an institutional *impasse*. In the euro area's short life, it was the first time that this possibility was formally put on the table. The probability of *Grexit* and consequent transformation of the EMU into a reversible fixed exchange rate *régime* have as yet not been significantly reduced. The political agreement reached by the European Council and the Greek government in mid-July 2015 is quite fragile, and the detailed 'technical' adjustment program signed by European institutions and Greece in mid-August will be hard to implement. Hence, it becomes crucial to analyze (i) the conditions that would make it convenient for a Member State in trouble to leave the euro area, and (ii) the possible impact of this exit on the behavior of other Member States.

Our paper focuses on a simple game between two stylized economic systems that react to a country-specific shock combined with the depreciation/appreciation of their common currency, with the aim of analyzing the consequences of an exit option. It thus offers a partial answer to questions (i) and (ii), above.

Our paper is unable to fully address question (i) since the exit of a given country from a monetary union cannot be reduced to an "in/out" alternative mainly based on the (non-)flexibility of its exchange rate and consequent impact on its price competition in international markets. The advantages and costs of the possible exit of a given country largely depend on the transition from the current *régime* (inside the monetary union) to the new one (outside the monetary union). In turn, the main features of this transition are deeply influenced by the legal and institutional setting of the monetary area and by the structural, economic, and social organization of the country in question (cf. Boltho-Carlin 2013). Therefore, to assess the convenience of an exit from the euro area, it would be necessary to combine a large number of theoretical, institutional, and organizational components, but this is beyond the capability of our model. Likewise, our paper is unable to offer a general answer to the second question - the possible reaction of other Member States of a monetary union to a country's exit from this same union. As with the former question, it would be necessary to take into account a large number of institutional aspects as well as the specific economic and social features of each of the Member States potentially involved in the exit.

Despite these limits, our paper is able to offer original partial answers to both these crucial questions. It examines a monetary union composed of different types of countries: at first approximation, a Member State affected by economic fragilities and lack of structural competitiveness, and another more robust and competitive Member State than the previous one. This simple setting can be conceived as a stylized representation of part of the euro area. The first country (country A) can approximate Greece or a representative of a set of peripheral countries with a significant probability of exiting from the monetary union if affected by negative shocks (i.e. a crisis of European sovereign debt and/or banking sector); the second country (country B) can approximate either Germany and its satellites (that is, the 'central' Member States in the euro area) or, even better, a set of semi-peripheral/semi-central countries (such as, respectively, Italy and France), which are exposed to a direct contagion due to the possible exit of country A.

In the following sections, we will interpret the analytical results of our model by identifying country A as the most vulnerable EMU peripheral Member States from an economic point of view (for instance:

Greece, Cyprus, and Portugal), and country *B* as the EMU Member States which are more solid than the peripheral ones, despite being characterized by structural disequilibria (such as the debt on the Italian government's balance sheet) or by an increasing lack of competitiveness (such as the French industrial sector). Our paper aims to assess the effects of the euro's appreciation/depreciation on the probability that peripheral country *A* leaves the EMU when hit by a negative and specific demand shock. We also analyze the role played by the euro's appreciation/depreciation on the contagion probability from country *A* to country *B*.

However, given this exogenous negative shock, we acknowledge that the euro's appreciation/ depreciation cannot be the only variable affecting the exit probability of peripheral Member State *A*. Even in our simplified model, it is necessary to take into account that price competition is not the only tool that a European country can utilize to be competitive in international markets (see Corsetti 2015). Hence, given that it would be analytically too difficult to endogenize institutional or organizational variables in our theoretical model, we point out that the dependence of the exit probability of country *A* from the euro's appreciation/depreciation is affected by its trade balance elasticities to its real effective exchange rate: the higher this elasticity, the more likely the country's exit from the euro. This is equivalent to stating that the elasticity of country *A* is a proxy for the importance of euro appreciation/depreciation with respect to a set of other variables given exogenously. On the other hand, this setting makes it possible to offer a more articulated analysis of the impact of country *A*'s exit on the exit of country *B* as a result of the contagion effect. We show that the possibility of contagion is also affected by the trade balance elasticity of country *B* to its effective exchange rate relative to the corresponding elasticity of the peripheral country. In particular, if the elasticity of country *B* is low enough, contagion can never occur.

Our model could offer a more comprehensive analysis of the working of the euro area if it encompassed strategic interactions between three agents: a country *E* representing the EMU's 'central' Member States (that is, Germany and its satellites), in addition to countries *A* and *B*. However, it is well known that the reference to a strategic interaction with more than two players increases the complexity of the analytical setting (cf. Papadimitriou 2007; Chen et al 2009). Hence, in the following analysis, we will assume that Germany and other central EMU Member States do not react to measures implemented by countries *A* and *B*. This implies that the EMU's country *E* will play an explicit role even less apparent than the one played by the extra-EMU world. In fact, we will take any currency appreciation/depreciation relative to the euro as a benchmark; and by definition, the euro cannot appreciate/depreciate toward itself.

This paper is the ideal evolution of Canofari *et al.* (2015), which, in turn, refers to the literature on the EMU crisis due to exchange rates effects. There exists a long list of papers that analyze the possible crises of fixed exchange rate *régimes*. It is possible to identify at least two broad approaches for the explanation of these currency crises. The first type, known as "first generation models," starts from Krugman (1979) and Flood and Garber (1984). According to this approach, the collapse of the fixed exchange rate *régime* is ascribable to a misalignment in fundamentals due to inconsistent macroeconomic policies. The second type, known as "second generation models", starts with the contribution by Obstfeld (1986) and also includes the role played by economic fundamentals (see Jeanne 1997). It thus becomes possible to stress self-fulfilling expectations as determinants of currency crises by emphasizing the role of credibility, expectations, and policy trade-offs. Recent works attempt to adapt and extend the insights of this literature to monetary unions. In this vein, De Grauwe and Ji (2012) present a model of the EMU sovereign crisis inspired by the Obstfeld (1994, 1997) model of self-fulfilling speculative attacks. Moreover, Buiter *et. al.* (1996) introduce the role played by strategic interactions between European countries to explain the collapse of the European exchange rate mechanism (see also Di Bartolomeo *et al.* 2006).

The present paper introduces an important innovation with respect to all these papers. Its analytical framework is tailored to take into account a number of recent and crucial empirical aspects of the European crisis. This is the reason why we started this section with an explicit reference to the Greek crisis. There are other papers that analyze the Greek crisis using theoretical tools. For instance, drawing from the sizable literature on exchange rate crises, Arghyrou and Tsoukalas (2011) argue that the Greek crisis can be interpreted as the result of a deterioration of Greek macroeconomic fundamentals between 2001 and 2009, which make Greece's participation in the EMU inconsistent in the long-term (see also: German Council of Economic Experts 2015). However, as far as we know, our paper is the only one able to build a full bridge between the previous literature on exchange rates effects and the Greek crisis by means of a formal model.

The remainder of this paper is organized as follows. In section 2, we define the general framework of our model. The third section illustrates the structure of the game and the different in/out *régimes* involved when the peripheral country is hit by an exogenous shock. In the fourth section, we analyze the role played by the euro depreciation (appreciation) in offering disincentives (incentives) to peripheral country *A* to leave the monetary union, and hence in stabilizing (destabilizing) the monetary union. Then, we assume the exit case for country *A* and consider the probability of a contagion effect from this exit for country *B*. The fifth section specifies the peculiar role played by trade balance elasticities on effective exchange rate for the cases examined in the previous section. The last section offers some conclusions and propose avenues for further research.

2. THE GENERAL MODEL

Let us consider an economy characterized by two countries, A and B, which strategically interact. Both countries belong to the same monetary union, which can be interpreted as a partial and stylized representation of the European Economic and Monetary Union (EMU). In this respect, country *A* is representative of the euro area peripheral Member States, whereas country *B* is representative of the euro area Member States considered as intermediates between the 'central' and 'peripheral' countries. The other EMU countries could be denoted by *E*, whereas the rest of the world outside the EMU could be denoted by W. The nominal exchange rates s^z (where $z = A$, B, and W) measure the relative value of the currency of countries A and/or B (in case of exit), and of the currency of the representative country *W* (which stands for the rest of the world) in terms of the currency of the monetary union we are taking into consideration (i.e., the currency of country *E*).[1] This implies that an increase (decrease) in s^z represents a depreciation (appreciation) for country *z*.

As already explained, in order to focus on the possible exit choice of country *A* from the monetary union and the possible consequent contagion to country B, we assume that the rest of the EMU countries and the world outside the EMU do not react to the initiatives taken by countries *A* and *B*,

[1] Let us re-state that there is a devaluation/revaluation for countries *A* and *B* toward country *E* only in the case in which these two countries decide to exit from the monetary union; otherwise, their exchange rate could only depreciate/appreciate with respect to the rest of the world *W*. In the latter case, we analyze the exogenous appreciation/depreciation of the currency of representative country *W* in terms of the currency of representative country *E*.

which represent the only strategic agents. This implies that the exchange rate of country *E* (representing the rest of the EMU), which does not change by definition toward itself, can be made equal to one in level and zero in logarithm. The reference to the extra-EMU world allows us to measure the average effects of the appreciation/depreciation of the common currency with respect to the world outside the EMU. Let us add that, in our model, all the prices are normalized to 1 in level (0 in logarithm). This implies that inflation rates are only driven by the change in nominal exchange rates.

To further simplify the analysis, we assume that the structural parameters of countries A and B are identical except for trade balance elasticity σ_j to the real effective exchange rate (*REER*j) (where j = A, B). The elasticity σ_j is the only factor of heterogeneity between the two countries. This appears as a drastic simplification, but by stating that the elasticity of country A (σ_A) cannot be equalized to the elasticity of country B (σ_B), we are able to capture the fundamental, structural differences between the two representative countries.

In this respect, both the conditions ($\sigma_A < \sigma_B$ and $\sigma_A > \sigma_B$) can be applied in the short term. Obviously, if $\sigma_A < \sigma_B$, it is implied that the potential growth of country *A* is less dependent on currency depreciation, and, hence, on price competition; conversely, if $\sigma_A > \sigma_B$, it is implied that the potential growth of country *A* is more dependent on currency depreciation, and, hence, on price competition However, in both cases, the relative dependency of the peripheral country can be interpreted in terms of its weaker productive organization and more traditional specialization relative to the other EMU country. In the first case ($\sigma_A < \sigma_B$), the actual economic structure of country *A* is so weak, making its position in the international markets so marginal, that a one-shot depreciation is insufficient to fill the negative competiveness gap with the rest of the world. This explains why the trade balance elasticity of country *A* will be lower than that of country *B*, even if the latter does not mainly base its international competitiveness on prices. In the second case ($\sigma_A > \sigma_B$), the economic structure of country *A* is strong enough to positively react to the depreciation; in this case, the traditional specialization of country *A* explains why its trade balance elasticity is higher than that of country *B*, since the latter does not mainly rely on prices for international competitiveness.

In the following analysis, we assume that, at least in the long term, the EMU's economies are sufficiently involved in the international markets to make the case of $\sigma_A > \sigma_B$ predominant. Hence, in our model, the assumption $\sigma_A > \sigma_B$ is a stylized representation of the negative gap in terms of innovative production and structural competitiveness suffered by country A with respect to country B .[2]

The *REER*A is determined by the exchange rate of this same country (s^A), by the exchange rate of the other interacting country *B* (s^B), and by the average exchange rate of the rest of the world *W* (s^W). As indicated above, s^z (where z = *A*, *B,* and *W*) are nominal variables, and the world exchange rate s^W represents the channel to assess the role played by the depreciation/ appreciation of the currency of

[2] Here, the term 'structural competitiveness' stands for competitiveness based on innovative factors and not just on wage and price devaluation. In a more complex model with three strategic agents, it would also become possible to relate the elasticity of countries *A* and *B* to the EMU's central country (E). It would follow, in this case, that although we can have σ_A □ σ_B, we certainly have $\sigma_B > \sigma_E$.

the monetary union under consideration.[3] The exchange rates s^B and s^W are weighted, respectively, by the parameters β and Υ, whose value is determined by the relevance of different trade partners for country A ($0 < \beta$, $\Upsilon < 1$; and also: $\beta + \Upsilon < 1$).[4] Hence, the real effective exchange rate of country A is equal to:

$$REER_A = \left\lfloor(-1+\beta+\gamma)s^W - \beta s^B + s^A\right\rfloor \quad (1).$$

The same reasoning applies to the determination of $REER_B$. For the sake of simplicity and without significant loss of generality, we assume that the parameters β and Υ are the same for countries A and B.[5] Hence, the real effective exchange rate of country B is equal to:

$$REER_B = \left\lfloor(-1+\beta+\gamma)s^W - \beta s^A + s^B\right\rfloor \quad (2).$$

The output gaps of country A and country B, y^A and y^B - respectively, depend on the real effective exchange rates of these two countries. Moreover, as stated above, we assume that only the representative peripheral country A is affected by an exogenous negative demand shock u^A;[6] no exogenous shocks occur for country B. Given this assumption, equations (1) and (2) lead to the equilibrium in the goods markets of the two interacting countries, and we arrive at:

$$y^A = \sigma_A\left\lfloor(-1+\beta+\gamma)s^W - \beta s^B + s^A\right\rfloor - u^A \quad (3)$$

$$y_t^B = \sigma_B\left\lfloor(-1+\beta+\gamma)s^W - \beta s^A + s^B\right\rfloor \quad (4)$$

where σ_A and σ_B ($\sigma_j > 0$; with $j = A, B$) denote, respectively, the trade balance elasticity to the real effective exchange rates of the two countries under examination.

Let us assume for the moment that $u^A = 0$. It follows that, by definition, in equilibrium, outputs and inflation rates are at their target levels for both countries. Given the nominal exchange rates definition above, an increase in s^A determines an increase in $REER_A$, reflecting a real depreciation for country A and a consequent improvement in its price competitiveness. The latter leads to an increase in the international demand for goods produced by this same country. Given the value of this decrease in s^A,

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[3] Let us recall that s^W is the average of the exchange rates of the non-EMU world. Hence, increases in s^W can be typically determined by an appreciation of the euro toward any other currency not related to countries *A* and *B* (in case of their exit).

[4] The parameter β is the weight of the other strategically interacting country, and $1-\beta-\gamma$ is the weight of the rest of the extra-EMU world (where γ takes into account that a part of the rest of the world belongs, by assumption, to the EMU's 'central' countries). Obviously, $\beta + \Upsilon$ must be strictly lower than 1; otherwise, the weight of the non-EMU rest of the world would be equal to 0 despite the processes of globalization.

[5] As a matter of fact, the two countries tend to have different parameters since the relevance of each of the trade partners is specific for peripheral country *A* and for country *B,* due to their different economic structure and specialization. However, the introduction of two additional parameters would complicate the algebra; we can indirectly account for these differences between the two countries by means of their specific trade balance elasticity σ_j (see above).

[6] This is an i.i.d. random shock described by a continuous, bell-shaped, and symmetric (around zero) probability density function.

the intensity of the positive impact on demand will depend on σ_A as well as the value of the two parameters β and Υ.

On the other hand, an increase in s^B or s^W determines a decrease in *REER*A, reflecting a real appreciation for country *A* and a consequent deterioration in its price competitiveness. The latter leads to a decrease in the international demand for goods produced by this same country. Given the value of the increases in s^B and s^W, the intensity of the negative impact on country *A*'s international demand and the increase in country *A*'s output gap will depend on σ_A and the value of the two parameters β and Υ. The same reasoning applies to country *B*. However, it is necessary to take into account that σ_A is assumed to be greater than σ_B. Hence, other things being equal, the impact of a real appreciation/depreciation of country *B*'s currency has a lower intensity for it than for country *A*.

To complete the general framework of our model, it is necessary to specify the possible interactions between countries *A* and *B*. In principle, each of these two countries can choose to stay in or leave the monetary union (in our case, the EMU). This implies that there are four possible *régimes*: no country abandons the EMU (*régime* N); only country A exits (*régime* D^A); only country B exits (*régime* D^B); both countries leave the EMU (*régime* F). The strategic choice of each country depends on the welfare losses arising from each *régime*. In fact, both the governments of country *A* and country *B* aim at minimizing a loss function L^j (where *j* = *A*, *B*), defined over the output gap and inflation rates:

$$L^A = \left(y^A\right)^2 + \theta\left(s^A\right)^2 + \delta C \tag{5}$$

$$L^B = \left(y^B\right)^2 + \theta\left(s^B\right)^2 + \delta C \tag{6}$$

where L^A and L^B denote the loss functions to be minimized for, respectively, country *A* and country *B*; and θ is the coefficient of inflation aversion (with $\theta > 0$). Following our previous assumptions, this latter coefficient is equal for the two countries. We already know that y^A and y^B represent the output gap for these same countries; s^A and s^B are the nominal exchange rates. Given the structure of our model, s^A and s^B also represent the inflation rates for both countries. Finally, δ is a dummy variable defined as $\delta = 0$, if the country remains in the monetary union, and $\delta = 1$ if it chooses to exit.

Consistent with the second generation approach to currency crises (cf. above; and De Grauwe and Ji 2012), an exogenous opting out cost C is included.[7]

[7] The constant *C* can be interpreted as a non-pecuniary cost due to the loss of reputation that countries *A* and *B* would suffer at the international level by breaking the unity of the monetary area. On the other hand, *C* can also be interpreted as the total monetary cost of exit. This latter cost includes a number of items. For instance: the cost of giving up the commitment to repay the stockpile of old debts in the old currency, the transaction costs involved in the currency change, the reorganization of the national payment system, and the cost of switching to a flexible exchange system. *C* also represents the strength of the peg. In short, we can state that the constant *C* summarizes all the costs not explicitly considered in the model connected to abandoning the monetary union, as described in the introduction of this paper.

3. EXOGENOUS SHOCK: THE STRUCTURE OF THE GAME

Let us refer to a game that starts when there is an exogenous and aggregate demand shock, so that the previous assumption of $u^A = 0$ does not apply. The shock (denoted as $u^A > 0$) directly affects only country A, even if it is observed by both A and B. This shock implies a deviation in the output and inflation of country A from their respective target levels.[8]

These assumptions do not fit with the narrative of the mid-2007 subprime mortgage crisis in the United States or its impact on European and international financial markets in 2008-09. In those years, there was a banking sector and stock market collapse in the most advanced systems; this collapse affected the 'real' economies in the most important areas of the world. However, in the second half of 2009, the recovery phase in the United States and in the euro area was stronger than expected, and it was perceived by many economists as a first step toward the return to previous target levels. Unfortunately, the economies of the United States and EMU followed different trajectories. Deviating from the United States and other international areas, the EMU's economic recovery was interrupted by the sovereign debt crisis and/or the banking sector crisis in three peripheral Member States (Greece, Ireland, and Portugal) and by the contagion to Italy and Spain. Our model and the related game structure are roughly consistent with these new negative economic episodes, which specifically affected the euro area.

The sovereign debt and banking crises, which partially were the consequence of the international crisis but which can also be represented by a negative exogenous shock hitting country A in our theoretical model, caused a severe recession in the Greek, Irish and Portuguese economies. On the brink of bankruptcy, these three economies were forced to sign on to aid programs with European institutions in order to re-finance their public balance sheet and remain in the euro area. We will refrain from assessing the main features of the aid programs launched by the EMU, and the possible links between the adjustment programs imposed on Greece, Ireland, and Portugal and the intensity of the recession in these same economies,[9] since policy issues cannot be included in our theoretical model. Here, we are only interested in the fact that, at least in principle, the impact of the recessionary phase could have pushed the three peripheral Member States to leave the EMU. *A fortiori*, this possible implication should apply to the most recent Greek crisis, which reached its peak between mid-June and mid-July 2015. Hence, in our model, it is interesting to evaluate the impact that an exogenous shock can have on the selection of one or more of the four *régimes* characterizing the game (see above, section 2): no country abandons the EMU (regime N); only country A exits (regime D^A); only country B exits (regime D^B); both countries leave the EMU (regime F).

Losses for both countries A and B in each of the four *régimes* are represented by the following payoff matrix:

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[8] The economic systems of both countries *A* and *B* are in equilibrium in the absence of shocks; as mentioned above, we assume that, in equilibrium, output and inflation are at their target levels.

[9] There is a rich collection of literature analyzing the possible impact of austerity programs and the consequent European policies on the EMU's economic recession, which was particularly severe and prolonged in 'peripheral' countries. Here, we just refer to: Barkbu *et al.* 2015; Baldwin and Giavazzi 2015.

A \ B	No Exit	Exit
No Exit	L_N^A ; L_N^B	$L_{D^B}^A$; $L_{D^B}^B$
Exit	$L_{D^A}^A$; $L_{D^A}^B$	L_F^A ; L_F^B

where L_h^j represents the loss for country j (with $j = A, B$) in regime h (with $h = N$, D^A, D^B, F).

Using the previous matrix, it thus becomes possible to check for the existence of a Nash equilibrium and, in the affirmative, for unique or multiple Nash equilibrium solutions. We indicate the costs which country A and country B respectively suffer by deviating from each *régime* as:

$$a_1 \equiv L_{D^B}^A - L_F^A,\ \ a_2 \equiv L_{D^A}^A - L_N^A,\ \ b_1 \equiv L_{D^A}^B - L_F^B,\ \ b_2 \equiv L_{D^B}^B - L_N^B \quad (7).$$

Definition (7) allows us to state the following:

Proposition 1 *A specific* régime *is a Nash equilibrium if both countries have no incentive to deviate from it. Formally:*

Régime F is a Nash equilibrium $\Leftrightarrow$ $a_1 > 0$ and $b_1 > 0$.

Régime N is a Nash equilibrium $\Leftrightarrow$ $a_2 > 0$ and $b_2 > 0$.

Régime D^A is a Nash equilibrium $\Leftrightarrow$ $a_2 < 0$ and $b_1 < 0$.

Régime D^B is a Nash equilibrium $\Leftrightarrow$ $a_1 < 0$ and $b_2 < 0$.

Let us recall that the aim of each of the two governments is the minimization of its respective loss function. Hence, the optimal reaction functions for both countries are obtained by minimizing (5) and (6) with respect to the nominal exchange rates subject to conditions (3) and (4), respectively.[10]

We obtain for country A:

$$s^A = 0 \qquad \text{if } \delta = 0$$

$$s^A = \frac{\sigma_A\left\{\left[(1-\beta-\gamma)s^W + \beta s^B\right]\sigma_A + u^A\right\}}{\sigma_A^{\ 2} + \theta} \qquad \text{if } \delta = 1 \quad \text{(8A)}$$

[10] The economic meaning of the constraints (3) and (4) in the minimization problem is that the goods market must be equilibrium in both countries.

and for country *B*:

$$s^B = 0 \qquad \text{if} \quad \delta = 0$$

$$s^B = \frac{\sigma_B{}^2\left\{\left[(1-\beta-\gamma)s^W + \beta s^A\right]\sigma_A\right\}}{\sigma_B{}^2+\theta} \qquad \text{if} \quad \delta = 1 \qquad \text{(8B).}$$

Given Proposition 1 and equations (8A) and (8B), the optimal strategies of the two countries in each *régime* are:

$$RegimeN:\left\{s^A = 0, s^B = 0\right\} \tag{9}$$

$$RegimeD^B:\left\{s^A = 0, s^B = -\frac{\sigma_B{}^2 s^W(-1+\beta+\gamma)}{\sigma_B{}^2+\theta}\right\} \tag{10}$$

$$RegimeD^A:\left\{s^A = -\frac{\sigma_A\left[s^W(-1+\beta+\gamma)\sigma_A - u^A\right]}{\sigma_A{}^2+\theta}, s_t^B = 0\right\} \tag{11}$$

$$RegimeF:\left\{\begin{array}{l} s^A = \dfrac{\left\{(-1+\beta+\gamma)\left[(1+\beta)\sigma_B{}^2+\theta\right]s^W\sigma_A - u^A\left(\sigma_B{}^2+\theta\right)\right\}\sigma_A}{\left[\left(-1+\beta^2\right)\sigma_B{}^2-\theta\right]\sigma_A{}^2-\theta\sigma_B{}^2-\theta^2} \\ s^B = \dfrac{\left[(1+\beta)(-1+\beta+\gamma)s^W\sigma_A{}^2 - \sigma_A u^A\beta + s^W\theta(-1+\beta+\gamma)\right]\sigma_B{}^2}{\left(-\sigma_B{}^2-\theta+\beta^2\sigma_B{}^2\right)\sigma_A{}^2-\theta\sigma_B{}^2-\theta^2} \end{array}\right\} \tag{12}$$

Substituting (9)-(12) in (5) subject to (3), the losses for country A in the different *régimes* become:

$$L_N^A = \left[s^W(-1+\beta+\gamma)\sigma_A - u_t^A\right]^2 \tag{13}$$

$$L_{D^A}^A = \frac{\left[\theta s^W(-1+\beta+\gamma)\sigma_A - u_t^A\right]^2}{\sigma_A{}^2+\theta} + C \tag{14}$$

$$L_{D^B}^A = \frac{\left\{(-1+\beta+\gamma)\left[(1+\beta)\sigma_B{}^2+\theta s^W\sigma_A\right] - u_t^A\left(\sigma_B{}^2+\theta\right)\right\}^2}{\left(\sigma_B{}^2+\theta\right)^2} \tag{15}$$

$$L_F^A = \frac{\left(\sigma_A{}^2+\theta\right)\theta\left\{(-1+\beta+\gamma)\left[(1+\beta)\sigma_B{}^2+\theta\right]s^W\sigma_A - u_t^A\left(\sigma_B{}^2+\theta\right)\right\}^2}{\left\{\left[\left(-1+\beta^2\right)\sigma_B{}^2-\theta\right]\sigma_A{}^2-\theta\sigma_B{}^2-\theta^2\right\}^2} + C \tag{16}$$

Then, substituting (9)-(12) in (6) subject to (4), the losses for country B in the different *régimes* become:

$$L_N^B = \sigma_B{}^2(-1+\beta+\gamma)^2\left(s^W\right)^2 \tag{17}$$

$$L_{D^B}^B = \frac{\sigma_B{}^2(-1+\beta+\gamma)^2\left(s^W\right)^2\theta}{\sigma_B{}^2+\theta} + C \tag{18}$$

$$L^B_{D^A} = \frac{\left\{\left(-1+\beta+\gamma\right)\left[\left(1+\beta\right)\sigma_A{}^2+\theta\right]s^W - \sigma_A u^A \beta^2\right\}\sigma_B{}^2}{\left(\sigma_A{}^2+\theta\right)^2} \tag{19}$$

$$L^B_F = \frac{\left\{\left(-1+\beta+\gamma\right)\left[\left(1+\beta\right)\sigma_A{}^2+\theta\right]s^W - \sigma_A u^A \beta^2\right\}\theta\left(\sigma_B{}^2+\theta\right)\sigma_B{}^2}{\left[\left(-\sigma_B{}^2-\theta+\beta^2\sigma_B{}^2\right)\sigma_A{}^2-\theta\sigma_B{}^2-\theta^2\right]^2} + C \tag{20}$$

4. CURRENCY DEPRECIATION AND OPTING OUT

Based on the conclusions of Canofari *et al.* (2015), it is easy to extrapolate from Proposition 1 and equations (13) – (20) that country B would never leave the monetary union (in our case, the EMU), and thus it would never depreciate its corresponding currency, assuming country A decided to stay in that union despite the impact of its specific exogenous shock. This means that D^B is never a Nash equilibrium. Moreover, the same proposition and equations allow us to determine a threshold level for the exogenous shock hitting country A (u_A^*) which makes it indifferent for this country to stay in or opt out from the monetary union. In this respect, it is sufficient to solve the condition $L^A_{D^A} - L^A_N = 0$ for a specific value of u^A. From equations (7) and (8A), we get:

$$u_A^* = \frac{\sqrt{C\left(\sigma_A{}^2+\theta\right)} + \left(-1+\beta+\gamma\right)s^W\sigma_A{}^2}{\sigma_A} \tag{21}$$

Equations (21) and (3) imply that, if the shock hitting country A exceeds u_A^*, this country will choose to leave the monetary union and depreciate its consequent new currency.[11] In this event, *régimes* D^A or F are the Nash-equilibrium solution depending on the reaction of country B. Equation (21) also shows that the possible choice of country A to opt out of the monetary union is also indirectly affected by the nominal exchange rate of the rest of the world (s^W) and the possible appreciation/depreciation of the monetary union currency. In fact, according to equation (21), changes in s^W implies changes in u_A^*. This is equivalent to stating that an appreciation/depreciation of the monetary union currency would affect the value of the exogenous shock hitting country A, which makes it indifferent for this country to stay in or opt out of the monetary union.

In order to better assess this new aspect, let us differentiate (21) with respect to s^W, obtaining:

$$\frac{\partial u_A^*}{\partial s^W} = \left(-1+\beta+\gamma\right)\sigma_A \tag{22}$$

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[11] This obviously means that country *A* will stay in the monetary union if its specific shock is lower than u_A^*. As usual, the former results leave the choice of country *A* undetermined when the specific shock is equal to u_A^*. Through algebra, it would be possible to overcome this indeterminacy. However, we assume, for the sake of simplicity, that country *A* always chooses to stay in when the specific shock is equal to u_A^*.

Given that $\beta + \Upsilon < 1$ and $\sigma_A > 0$ (see above), equation (22) clearly states that $\frac{\partial u_A^*}{\partial s^W}$ is negative Hence, *ceteris paribus*, an appreciation of s^W that improves the price competitiveness of country *A* would increase the threshold level u_A^* so that the exit of country A from the monetary union is less likely to occur. The opposite would obviously hold true in the case of a depreciation of s^W, which weakens the price competitiveness of country *A*. In this case, the value of u_A^* would decrease so that the exit of country *A* from the monetary union would be more likely to occur. The conclusion is that the depreciation of the euro increases the stability of the EMU.

This result is quite significant for the further assessment of the recent evolution of the euro area. It emphasizes a possible negative implication of the adjustment programs implemented by European institutions to overcome the disequilibria and related economic difficulties of the peripheral Member States. It is well known that these programs led to restrictive fiscal policies and hindered the adoption of expansionary unconventional monetary policies, except at the peak of the banking crisis (December 2011 – June 2012) and quite recently (since March 2015). Due to more active policies implemented in other main economic areas (the United States, China, Japan, and the United Kingdom) since mid-2012 to the third quarter of 2014, the euro appreciated with respect to the other most important international currencies. Hence, our analytical result allows us to conclude that, other things remaining equal, restrictive European policy measures contributed to increasing the probability that some peripheral Member States might opt out.

We should not neglect these findings in the face of the current renewal of the Greek crisis. As stated, the European Central Bank (ECB) started the implementation of a strong program of quantitative easing in March 2015; it is well known that financial markets anticipated this decision since November 2014, resulting in a depreciation of the euro relative to the US dollar during the following six months. Hence, even if we assume that the imposition of too restrictive economic policies could push Greece outside the euro area and thus turn either D^A or *F* into the EMU's dominant *régime*, we will have to take into account that the ECB's current monetary policy can act as a counterbalance.[12]

Régime N, which corresponds to a stable working of the monetary area, can actually be selected. It is sufficient that the exogenous shock hitting country *A* satisfies the condition $u_A \leq u_A^*$ (see Fig. 1 and footnote 11). In this case, as stated by equations (21) and (3), country A will not leave the monetary union; this will also imply that country *B* stays in. Since r*égime N* is a Nash equilibrium, it follows that, at least in principle, the EMU can select a stable equilibrium with the capacity to absorb external shock. On the other hand, our model allows for the selection of the spurious *regime* ($D^A \cup F$). If the exogenous shock hitting country *A* leads to $u_A > u_A^*$, country A will decide to leave the monetary union (see Fig. 1). In this case, country *B* can either stay in or opt out due to contagion. Hence, both *régimes*, D^A and F, can be Nash equilibria. This implies that, at least in principle, the EMU can also select bad equilibria: D^A tends to transform a monetary union into a very unstable fixed exchange rate

[12] Let us stress that our statement is not affected by the fact that the ECB's quantitative easing does not apply to the purchase of Greek bonds since Greece is under an EMU aid program. In any event, the previous conclusion shows that analytical achievements attained through our model can contribute to a better understanding of the evolution of the EMU.

monetary system,[13] whereas F implies an even more dramatic breakdown of the monetary union.[14]

Fig. 1

u_A --------------------------------|----------------------------------- u_A

N *régime* u_A^* $D^A \cup F$ *régime*

A simple refinement of our model allows us to be more precise in selecting the bad equilibrium - when country A decides to leave the monetary union due to the fact that $u_A > u_A^*$. In this respect, let us derive another threshold level for the shock hitting country A. This new threshold for u_A, other than satisfying the condition $u_A > u_A^*$ (a necessary condition for the exit of country A), must make it indifferent for country B to stay in or opt out from the monetary union. In other words, it has to satisfy the condition $L^B_{D^A} - L^B_F = 0$ for the specific value of u^A. Thus, we get the new threshold level u_A^{**}. The latter implies that country B will remain in the monetary union despite the exit of country A, if the actual exogenous shock affecting the latter country is lower than u_A^{**} ($u_A < u_A^{**}$).[15] On the other hand, country B will also choose to opt out of this monetary union (in the case of contagion) if the actual exogenous shock affecting country A is large enough to determine the condition $u_A > u_A^{**}$.

The expression which determines u_A^{**} is too complex to be explicitly reported in the text. Its implicit form is:

$$u_A^{**} = f(\beta, \gamma, \theta, \sigma_A, \sigma_B, C, s^W) \qquad (23)$$

Let us emphasize two features of equation (23). First, it seems reasonable to assume that $u_A^{**} > u_A^*$ since this is equivalent to assuming that the minimum level of shock capable of generating contagion is greater than the minimum level of shock needed to obtain the exit of country A without contagion.[16]

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[13] In the past forty years, European attempts to create a fixed exchange rate system failed, as exemplified by the reaction to the breakdown of the Bretton Wood agreements and the construction of the European Monetary System. A few years after President Nixon's obviation of the gold standard (mid-August 1971), European countries built up a quasi-fixed exchange rate system, which summarily collapsed due to financial speculation. The European Monetary System that started in the European Union in 1978 had a longer life, lasting until 1992-'93. However, this life was characterized by several re-alignments of different currencies (the Italian lira, for instance), and it later collapsed in the fall of 1992 with the exit of the Italian lira and British pound. We are choosing to ignore its formal existence in the years after 1993 since it was based on the introduction of very large exchange rate corridors between European currencies.

[14] It is quite clear that it would be impossible to conceive the survival of the EMU with the exit of Spain, Italy, and France. The new monetary area would be no more than a currency agreement between Germany and its satellites, one centered on the resurgence of the Deutsche mark.

[15] In this case as well, we will assume that country B always chooses to remain in if the shock affecting country A is equal to u_A^{**} (see footnote 11, above).

[16] In order to support the intuition proposed in the text, the Appendix shows that the inequality $u_A^{**} > u_A^*$ is actually satisfied for reasonable values of the parameters and for reasonable intervals in the values of the trade balance elasticities to the real effective exchange rates. Here, we are interested in the possible effect of euro depreciation on the probability of contagion for country B.

Additionally, the depreciation of the monetary union currency also affects u_A^{**}. In this last respect, we can differentiate u_A^{**} towards s^W to obtain:

$$\frac{\partial u_A^{**}}{\partial s^W} = \frac{(-1+\beta+\gamma)\left((1+\beta)\sigma_A{}^2+\theta\right)}{\beta\sigma_A} \qquad (24)$$

It is easy to check that $\frac{\partial u_A^{**}}{\partial s^W}$ is negative in this case as well. It follows that an appreciation of s^W (decrease in s^W), which implies a depreciation of the monetary union currency, reduces the probability of contagion because this depreciation increases the threshold level u_A^{**}.

To summarize, the exit of country *A* does not imply contagion, shown by *régime* D^A becoming a Nash-equilibrium, when $u_A^* < u_A \leq u_A^{**}$; on the other hand, the exit of country *A* also causes the corresponding exit of country *B*, shown by *régime F* becoming a Nash-equilibrium, when $u_A > u_A^{**} > u_A^*$ (see Fig. 2). Figures 1-2 and equations (22-24) confirm that the quantitative easing (QE) recently implemented by the ECB (referenced above) acts as a mechanism of stabilization for the EMU.

Fig. 2

u_A -------------------|--------------------|------------------- u_A

N *régime* u_A^* D^A*régime* u_A^{**} *F régime*

5. CONTAGION AND TRADE BALANCE ELASTICITIES

In this section, we aim to focus our analysis on the output gap elasticities of countries *A* and *B* (σ_A and σ_B, respectively) to the effective real exchange rates of these same countries. As we already stated (see section 2, above), we assume that the elasticity of the representative peripheral country *A* is higher than that of country *B* ($\sigma_A > \sigma_B$).[17] This assumption is supported by the fact that peripheral economies have a more traditional specialization and weaker productive organization than other countries of the monetary union. Hence, in our model, country *A* competes more on the depreciation of its effective real exchange rate (in other words, on prices) than on other innovative factors (such as organizational and technical innovations, product quality, and so on). The opposite holds true for country *B*.[18] This is the reason why we focus on the elasticity of the two countries under consideration. If we were able to show that the values of σ_A and σ_B have an impact on the decisions of country *A* and *B* to stay in or opt out of the monetary union, it would follow that the structural competitiveness of

[17] Formally, we could allow for a weaker condition, that is $\sigma_A \geq \sigma_B$. However, from an economic point of view, the stronger condition adopted in the text is more convincing.

[18] The simplification introduced in our model allows us to compare country *B* only to country *A*, keeping in mind that, in a more complex model with three interacting countries (*A*, *B*, and *E*), the representative central country *E* would be characterized by the lowest elasticity to its real effective exchange rate.

these two countries - their competitiveness based on innovative factors and their relative gap in terms of this same structural competitiveness - have an effect on the stability of a monetary union. This possible result would be important for the analysis of the EMU. It would confirm the thesis that one of the main factors of instability of the euro area is the weakness of peripheral Member States with respect to the rest of the area in terms of structural competition (cf. Eichengreen 2010; European Commission 2012).

In order to investigate the role played by the elasticities to real effective exchange rates in the relationship between country A and B, it is convenient to set the world exchange rate s^W equal to 0. Moreover, in order to avoid any reference to other factors of reciprocal influence exercised by these two countries on each other, let us eliminate the parameter β. In this manner, equation (3) becomes:

$$y^A = \sigma_A \left[s^A - s^B \right] - u^A \qquad \text{(3 bis).}$$

Combining equations (7) and (8A) as modified by equation (3 bis), we can solve $L^A_{D^A} - L^A_N = 0$ for u^A. The result is the determination of the threshold level (v^*) which makes it indifferent for country *A* to stay in or leave the monetary union given the value of σ_A:

$$v^* = \frac{\sqrt{C\left(\sigma_A^{\,2} + \theta\right)}}{\sigma_A} \qquad \text{(25).}$$

The economic meaning of equation (25) is quite similar to that of equation (21) (see section 4, above and Fig. 3, below). If country *A*'s specific shock u^A exceeds v^*, this same country will leave the monetary union and will depreciate its currency such that the possible dominant *régimes* become $D^A \cup F$. Instead, if u^A is lower than or equal to v^*,[19] country *A* will stay in the monetary union, making *régime* N a Nash equilibrium. It is obvious that if v^* increases, *ceteris paribus,* the probability that country *A* stays in will also increase.

Fig. 3

u_A ----------------------------|---------------------------------- u_A

N régime v^* $D^A \cup F$ *régime*

Let us stress that the value of v^* depends on σ_A. It is easy to assess the effect of the elasticity σ_A on v^*:

$$\frac{\partial v^*}{\partial \sigma_A} = -\frac{C\theta}{\sqrt{C\left(\sigma_A^{\,2} + \theta\right)}\,\sigma_A^{\,2}} \qquad \text{(26)}$$

Being $C, \theta > 0$, equation (26) clearly states that the higher the elasticity of country A the lower v^* becomes. As Fig. 3 shows, this is equivalent to saying that high values of σ_A leads to a high

[19] Needless to say, the assumption made in footnotes 11 and 15 applies.

probability that country A chooses to leave the monetary union, and, conversely, that low values of σ_A leads to a high probability that this same country chooses to stay in the monetary union. Applying this analytical result to the actual working of the EMU, we find confirmation of the thesis that the structural competitiveness of peripheral Member States has an impact on the stability of the euro area. Because there is a negative correlation between the strength of the structural competitiveness of a given EMU Member State and its elasticity to the effective real exchange rate, equations (25) and (26) tell us that the risk of an exit from the EMU would decrease and the euro area would become more stable, assuming peripheral Member States improved organizational and technical innovations and product quality.

Following the refinements introduced in the previous section, we can now be more precise about the conditions that would lead country *B* to select the bad equilibrium (D^A) or the worst equilibrium (*F*) when country *A* decides to leave the monetary union due to the fact that $u_A > v^*$.[20] In this respect, let us derive another threshold level for the shock hitting country A. This new threshold (v^{**}), other than satisfying the condition $u_A > v^*$ (a necessary condition for the exit of country *A*), must make it indifferent for country B to stay in or opt out of the monetary union, satisfying the condition $L^B_{D^A} - L^B_F = 0$ for the specific value of u_A. We thus get the new threshold level v^{**}:

$$v^{**} = \frac{\sqrt{\left(\theta\sigma_B{}^2 + \theta^2 - \sigma_A{}^4\right)C\theta\left(\sigma_A{}^2 + \sigma_B{}^2 + \theta\right)\left(\sigma_A{}^2 + \theta\right)}}{\left(\theta\sigma_B{}^2 + \theta^2 - \sigma_A{}^4\right)\sigma_B{}^2\sigma_A} \tag{27}$$

We can easily show that v^{**} is greater than v^*. From (27) and (25), we derive:

$$\frac{v^{**}}{v^*} = \frac{\sqrt{\theta}\left(\sigma_A{}^2 + \sigma_B{}^2 + \theta\right)\sqrt{\sigma_A{}^2 + \theta}}{\sqrt{\theta\sigma_B{}^2 + \theta^2 - \sigma_A{}^4}\,\sigma_B{}^2} = \frac{\sqrt{\sigma_A{}^2 + \theta}}{\sqrt{\sigma_B{}^2 + \theta - \frac{\sigma_A{}^4}{\theta}}} * \frac{\sigma_A{}^2 + \sigma_B{}^2 + \theta}{\sigma_B{}^2} > 1 \tag{28}$$

Equations (27) and (28) imply that country *B* will remain in the monetary union despite the exit of country *A* if the actual exogenous shock affecting the latter country is lower than or equal to v^{**} ($u_A < v^{**}$). On the other hand, country *B* will choose to opt out from this monetary union (case of contagion) if the actual exogenous shock affecting country *A* is large enough to satisfy the condition $u_A > v^{**}$. It follows that *régime* D^A becomes a Nash-equilibrium when $v^* < u_A \leq v^{**}$; conversely, *régime F* becomes a Nash-equilibrium when $u_A > v^{**} > v^*$.

Equations (27) and (28) also allow the rephrasing of previous results in terms of σ_A and σ_B (see

[20] It would have to be obvious that the bad equilibrium D^A is the best possible equilibrium given the exit of country *A*. This is equivalent to stating that, in the extended form of our game, country *B* is at a node where the 'bad' and 'worst' equilibria are the only possible outcomes.

Fig. 4a-4b). Whenever $\sigma_A \geq \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$ (or σ_B=0), $L^B_{D^A} - L^B_F$ will become negative for each shock level (see Fig. 4a); on the other hand, whenever $\sigma_A < \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$, $L^B_{D^A} - L^B_F$ will become positive if the shock exceeds the threshold level v^{**}(see Fig. 4b).

Fig. 4a

u_A ----------------------------|---------------------------------- u_A

N *régime* v^* D^A *régime*

$$\sigma_A \geq \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$$

Fig. 4b

u_A --------------------|-----------------------|--------------------- u_A

N *régime* v^* D^A*régime* v^{**} *F régime*

$$\sigma_A < \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$$

In other words, given the elasticity of country *A*, these new results imply that the selection between the bad and worst equilibrium will depend on the elasticity of country B. If the latter is zero or small enough ($\sigma_A \geq \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$), contagion can never be observed; conversely, if σ_B is high enough ($\sigma_A < \sqrt[4]{\sigma_B{}^2\theta + \theta^2}$), contagion and the direct breakdown of the monetary union becomes observable. This conclusion offers a stimulating interpretation of the working of the euro area. Country *B*, representing countries in between the 'central' and 'peripheral' Member States, can avoid contagion if it can maintain a low elasticity, achieving competitiveness through innovation rather than currency depreciation.

5. CONCLUSION

In this paper, we applied a simple "one shot" game to a monetary union in order to assess the conditions under which (i) the most fragile countries would likely leave the monetary area when affected by an exogenous and specific shock, and (ii) other, less fragile countries belonging to the same union would follow the same strategy due to contagion effects. Our main finding is that the depreciation (appreciation) of the currency of the area under examination reduces (increases) the probability that the country hit by the shock would choose to abandon the monetary union; the same effect is observed for the probability of contagion.

Our aim was to apply this result to the euro area in order to offer a stylized yet analytical interpretation of the recent Greek crisis. However, the achieved result is not sufficient for a credible representation of the workings of the euro area since it implicitly assumes European countries compete in the international markets solely through price competition. Hence, we also investigated the role played by output gap elasticities of real effective exchange rates. In this respect, we arrived at two interesting results: (a) the higher the elasticity of the most fragile countries affected by the shock, the higher the probability that these countries would find it convenient to abandon the monetary union; (b) given this elasticity, if the elasticities of other countries are low enough, the contagion effect will never display. This second result allowed us to conclude that the risk of an exit from the euro area depends on the fact that a subset of its most fragile Member States relies too much on price competition to improve competitiveness. Moreover, the risk that this exit would result in a breakdown of the monetary union due to widespread contagion effects can be reduced if other EMU Member States mainly based their competitiveness on organizational and technical innovations.

These conclusions are not robust enough to be econometrically proven due to the fact that leaving a monetary union involves a number of institutional and organizational factors that the current version of our theoretical model cannot take into account. Hence, the first analytical improvement for future research is to strengthen the analytical framework in order to include a stylized representation of institutional and organizational factors, replacing exogenous cost C in equations (5) and (6) with two cost functions that can represent the institutional and the organizational costs of an exit for both country A and country B, respectively.

From an analytical point of view, there are two other obvious improvements for future research. The first is to transform our two-agent game, which analyzes the strategic interactions between a 'peripheral' Member State and a more robust but not 'central' Member State in the euro area, confining the 'central' Member State to the background with a passive position, into a three-agent game containing a strategic interaction between three EMU Member States representative of 'peripheral', 'semi-central'/'semi-peripheral', and 'central' countries. The second improvement would be a more solid incorporation of institutional and organizational cost functions by making our "one shot" analysis a dynamic one. Let us emphasize that it would be useless to pass through a "repeated game." As shown by our simple "one shot" model, each round of interactions between two countries changes the structure regardless of an exit or non-exit outcome. Hence it is necessary to immediately build up a dynamic game (see Weibull 1995; Bașar and Olsder 1999; see also: van Aarle at al. 2002).

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APPENDIX

In the text, we maintained that it is reasonable to assume that $u_A^{**} > u_A^*$ since this is equivalent to assuming that the minimum level of shock capable of generating contagion is greater than the minimum level of shock necessary for triggering the exit of country *A* without contagion. However, we also stated in the text that it would have been possible to go beyond this intuition in the Appendix, by proving that $u_A^{**} > u_A^*$ under reasonable values for the parameters in equation (23) and reasonable intervals for the values of trade balance elasticities to the real effective exchange rates (σ_A and σ_B) .

Confirming this result, Figure A1 represents the values assumed by $(u_A^{**}/u_A^*) - 1$ for different values of σ_A and σ_B. The positive value of this function obviously satisfies the condition $u_A^{**} > u_A^*$. Let us assume that the values of the parameters are:

$$\beta = \frac{1}{3}, \gamma = \frac{1}{3}, \theta = 1, C = 1, s^W = 0.5$$

Given these values, which appear reasonable, it follows that we will remain in the positive portion of the figure if the elasticities σ_A and σ_B assume values between 0 and 2, which are also reasonable values.

Fig A1