# Post-crisis lesson for EMU governance from the principal-agent approach

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**Abstract**

This paper contributes to the ongoing debate on fiscal consolidation and the questionable effectiveness of the Stability and Growth Pact by addressing the problem of economic governance in the EMU with a game-theoretic principal-agent approach. Following the theory of delegation, we develop a principal-multi agent model where the EMU authorities act as a collective principal that designs contracts for each of two agents that reflect Europe's "South" and "North". We investigate what happens when agents face hidden-information moral hazard problem and when they are able to coordinate their actions. Bearing in mind the applicability of incentive mechanisms, we discuss the optimal contracts for the principal and each of the agents. We prove that the most efficient solution consists of tailor-made contracts, according to which highly indebted countries must be offered strong incentive mechanisms in form of severe punishments but also rewards (e.g. preferential loans). We also stress the importance of taking into account positive spillover effects, which could be facilitated by economic integration and fiscal policy coordination between the EMU Members.

*Keywords:* moral hazard, principal-agent, EU economic governance, Fiscal Compact.
*JEL:* D82, E61, H60.

## 1. Introduction

The global financial crisis exposed serious weaknesses in the design of the current economic governance framework in the European Monetary Union (EMU). The weak and in practice unenforceable fiscal rules laid down in the

Stability and Growth Pact did not prevent some of the Member Countries from being tempted to free-load by exploiting common credibility. Knowing that the entire union will bear the burden of their decisions, they can use private information about the condition of their economies to run excessive debts. With the backing of the more disciplined countries, the undisciplined put themselves at the edge of bankruptcy - and the EMU at the edge of a precipice.

This paper addresses these problems and following the theory of delegation, applies a formal principal-multi agent model that provides a useful parable for the current situation in the EMU.

The possibility of reforming the EU governance with indications stemming from the principal-agent approach has been addressed in a number of political economy articles. According to Hodson (2009), limited progress by some member states in achieving fiscal discipline is due to tensions within the collective principal and the weakness of ex-post sanctions. Promoting alignment of interests between the principal and the agents, as well as encouraging fire-alarm oversight at the member-state level could be a solution to the problem of moral hazard. Schuknecht (2004) finds that the self-enforceability of fiscal rules could be achieved with monitoring the public and markets. Moreover, fiscal rules need to be complex and sophisticated enough to find political support while retaining a necessary level of simplicity and clarity. Escape clauses from the simple 3% deficit threshold are in line with these findings, ensure fine-tuning and implementation of the entire mechanism.

Following the theory of delegation, we apply a more formal approach to the problem and build a principal-multi agent model, where monetary union authorities act as a collective principal that designs contracts for each of two agents that reflect Europe's current "North" and "South". Once the contract offered by the principal has been signed, the agents cannot breach it. After signing the contracts, the agents observe current economic market conditions, which are independently distributed among them, and use them as their private information when deciding on the effort they would exert. Since countries are affected by each-other policies in the form of spill-overs, at this stage they play a game, whose results will be crucial for the fiscal consolidation effort they perform.

With this approach we help shed light on the conclusions that can be

from the crisis: the design of European Fiscal Compact[1] and the European Stability Mechanism are only partly in line with effective mechanisms for the design of incentives for the EMU Member States that the agency theory suggests.

Keeping in mind the limited applicability of certain types of incentive mechanisms, we develop the optimal contracts for each of the agents. We show that by offering the same contracts to all countries, EMU authorities demand less effort than would be required for tailor-made contracts. We prove that countries that find it more painful to limit their debt burden must be offered stronger incentive mechanisms, not only as severe punishments but also in the form of rewards like e.g. preferential loans. We analyze what happens when agents are able to coordinate their actions. In this case, in order to take advantage of positive spill-over effects secure a and a better position to apply their expansionary tendencies, agents will be more willing to exert less effort once either a positive or negative shocks appears. We show that this will increase the efficiency of contracts, if the principal takes into consideration the fiscal consolidation effort exerted by the other party. In our conclusion, we summarize these observations and we attempt to determine which realistic options could be used to support the current EMU fiscal framework.

## 2. Agency perspective in the EMU

Delegation of tasks, conflicting objectives and asymmetric information are basic ingredients of the theoretical principal and agent relationship. The presence of these elements in the relationship between currency area authorities and member countries was identified in the economic literature earlier, but became much more visible after the global financial crisis. The last few years' troubled experience in the functioning of the EMU suggests that when analyzing the design of currency areas we might benefit from the principal-agent approach. To answer the question on how to design EMU institutions in order to provide good incentives for the Member States we need to identify rationale and characteristics of the principal-agent theory behind the EMU's case. The starting point will be to define conflicting objectives, i.e.

[1] *Treaty on Stability, Coordination and Governance in the Economic and Monetary Union*

the reasons why extensive deficits and growing imbalances between the EMU Member States arise.

*2.1. Economic reasoning behind extensive deficits*

Even without the special incentives that membership in a currency area gives, there are several reasons why countries tend to run excessive and time-inconsistent deficits. Some of the factors push governments to borrow extensively irrespective to their economic situation, some of them support either pro-cyclical or counter-cyclical fiscal policy. Selecting those which account for unwanted, time-inconsistent procyclical deficits would be important for building the optimal incentives mechanisms.

One of the reasons for running deficits has been diagnosed by Barro (1979) with the so called "tax smoothing model". According to the model, budget deficits and surpluses serve as a cushion that buffers low and high private spending in the economy. Since keeping government tax rates constant increases stability and induces private, governments adjust only the amount of their spending. Thus, with constant tax rates budget deficits are higher during the negative shocks. What according to Barro is a reason for running deficits in hard economic times, supports the idea of the optimality of counter-cyclical policies rather than explains procyclical tendencies of some EMU Member States.

Why governments are tempted by the extensive spending during sound economic times is explained partially by the concept of fiscal illusion reexamined in Buchanan and Wagner (l977). According to this idea, the public does not understand government budget constraints and believes in the sustainability of overestimated expenditures and underestimated revenues. A strong desire to be re-elected pushes ruling governments to take advantage of the asymmetry of information to win over voters, thus ending with debts. A ruling government is thus never willing to run surpluses, neither during recessions, nor recoveries. Alesina (2004) goes a step further and proves that an environment of corruption and imperfect information leads to favors paid by governments to special interests mostly during the booms. Another political economy factor that can support pro-cyclical fiscal policy is the electoral cycle. Nordhaus (1975) notes that voters reward the politicians that attract them with expansionary policies without bearing in mind that pre-electoral expansionary policies will not be followed by the "necessary" budget surpluses.

Although there are several factors behind the pro-cyclical tendencies of fiscal authorities, an overall conclusion can be drawn: countries with less developed institutions, larger asymmetries of information between governments and the public and higher levels of debt will find it harder to resist the temptation to run excessive deficits.

*2.2. Extensive deficits: the evidence from global financial crisis in EMU*

In a currency area the factors leading governments to run excessive deficits are even more numerous. The tendency of countries to increase their debt becomes stronger when they are confronted with common credibility and responsibility for actions. In this case, one of the major concerns is moral hazard, i.e. the temptation to exploit other member states that in any case will have to bear the cost of, e.g. lost reputation and rescue packages while not taking too much advantage of short-term expansionary fiscal policies run by some fellows.

The second major concern and obstacle that hinders sustainable fiscal policies of currency areas' members lies in the imbalances among them. Less wealthy economies, with weaker institutions, find it harder to resist the temptation to run excessive deficits. "Being insured" by the membership in a currency area without a proper incentive mechanisms can only increase such discrepancies.

What might happen when a group of countries with large imbalances faces a "common credibility" incentive in bad times has been clearly shown by the global financial crisis. Greece, Spain and Portugal were the countries whose central government debt rose by over 30 percentage points during 2007-2011. In fact, these countries not only increased indebtedness during the crisis, but they extended their deficits or kept them at a very high level (above 60% by Maastricht limit) in sound economic times before 2007. This group includes: Greece, Italy, Malta and Portugal. Figures presenting the behavior of the ratio of central government debt to GDP in the Old and New Member States are presented in Fig. 1.

In economies with limited buffers in the form of low public debt, financial crises very often lead to fiscal crises (see Reinhart & Rogoff, 2010). This clearly happened in the "Periphery" Member States but it also became a threat for the entire union, because central government debts of most EMU Members were very high before the crisis or not were not noticeably reduced during the sound economic times between 2001 and 2007. Thus, the current high levels of debt in Europe are the result of both the cost of rescue packages

Figure 1: Central government debt to GDP in the EMU Member States (percentage, 2007-2011)

| | 2001 | 2007 | 2009 | 2011 | change (2007-2001) | change (2011-2007) |
|---|---|---|---|---|---|---|
| **Euro area** | 68,2 | 66,4 | 80 | 87,3 | -1,8 | 20,9 |
| **Old Member States** | | | | | | |
| **Austria** | 66,8 | 60,2 | 69,2 | 72,4 | -6,6 | 12,2 |
| **Belgium** | 106,5 | 84 | 95,7 | 97,8 | -22,5 | 13,8 |
| **Finland** | 42,5 | 35,2 | 43,5 | 49 | -7,3 | 13,8 |
| **France** | 56,9 | 64,2 | 79,2 | 86 | 7,3 | 21,8 |
| **Germany** | 59,1 | 65,2 | 74,5 | 80,5 | 6,1 | 15,3 |
| **Greece** | 103,7 | 107,4 | 129,7 | 170,6 | 3,7 | 63,2 |
| **Italy** | 108,2 | 103,3 | 116,4 | 120,7 | -4,9 | 17,4 |
| **Ireland** | 35,2 | 25,1 | 64,9 | 106,4 | -10,1 | 81,3 |
| **Luxembourg** | 6,3 | 6,7 | 15,3 | 18,3 | 0,4 | 11,6 |
| **Netherlands** | 50,7 | 45,3 | 60,8 | 65,5 | -5,4 | 20,2 |
| **Portugal** | 53,8 | 68,4 | 83,2 | 108,1 | 14,6 | 39,7 |
| **Spain** | 55,6 | 36,3 | 53,9 | 69,3 | -19,3 | 33 |
| **New Member States (joined EMU after 2001)** | | | | | | |
| **Cyprus** | 61,2 | 58,8 | 58,5 | 71,1 | -2,4 | 12,3 |
| **Malta** | 60,5 | 61,9 | 67,6 | 70,9 | 1,4 | 9 |
| **Slovenia** | 26,5 | 23,1 | 35 | 46,9 | -3,4 | 23,8 |
| **Slovakia** | 48,9 | 29,6 | 35,6 | 43,3 | -19,3 | 13,7 |

*Data source: Eurostat*

and deficit spending before crisis. Such changes in debt-to-GDP ratios in the EMU Member States in the period 2001-2011 give scant evidence of desirable counter-cyclicality of fiscal policies.

The steady increase of public debt was not limited to "Periphery" Member States but also included France and Germany. This suggests that the geographical pattern of prudent North and imprudent South could be regarded as questionable (see Dabrowski, 2012). On the other hand, there is a difference in the mechanism that has driven debt of majority of countries of the core. Austria, Belgium, Finland, Luxembourg and Netherlands give more positive evidence of counter-cyclicality as they were able to keep their public debt in track before 2007 and to have a buffer for expansionary fiscal policy in the crisis.

*2.3. The need for proper rules*

Economic theory suggests two kinds of solutions to the free-rider problem in a collective action and hidden information environment. Because in such a problem participants' individual gains are matched by common losses, as a first type of solution an incentive mechanism that prevents exploiting the group's utility should be implemented if losses are to be minimized. Incentive mechanisms in the form of prizes and punishments could prevent agents from performing undesirable actions. Such incentives, however, must be applicable, enforceable and credible. Discretionary actions might not meet these tests, and in real life agents would rather have to be forced to obey strict and simple rules.

Since the main problem lies in the fact that the activity of the action's participants cannot be verified, reducing asymmetry of information is a second type of solution that could be a tool to support efficiency of such rules. In the optimal outcome a contract offered by the principal must exploit all available information about agents. In the agency framework, when either a type (e.g. how costly it is for country's government to employ contractionary fiscal policy) or agents' effort is unknown, principal his may implement investigation mechanisms. These mechanisms provide additional information and increase the chance of discovering agents' private information. In EMU economic governance the obligation to report, national accounting standards or Macroeconomic Imbalance Procedure could be regarded as such surveillance mechanisms.

The evidence of the global financial crisis shows that in a currency area we may face a typical free-rider problem of a collective action and hidden information environment that could be analyzed in the principal-agent framework. We may assume that EMU institutions act as a collective principal whose goal is to ensure the smooth working of the entire union. Institutions, however, do not have a good knowledge about the state of the economy in the Member States. This is why the 'principal' does not know how much effort each of their agents should exert. The knowledge of the EMU institutions is limited to observing the overall economic situation in the Member States. Having this limited knowledge at their On the other side agents governments of the Member States, are willing to exert as little effort as possible when not being punished by the principal. Prudent fiscal policy could be thought as the costly work that agents want to limit. Moreover, in the currency area there exists a problem of spill-overs between agents. Expansionary policy in one

of the member countries has a positive effect on the economic performance of others.

The current EMU governance envisages a policy that resembles the first solution to the free-rider problem described at the beginning of this section. The most important role, next to surveillance mechanisms, in the existing incentives framework in the EMU governance in preventing countries from excessive indebtedness, is played by the incentives mechanisms laid down in the Stability and Growth Pact (SGP). Hodson (2009, p. 460) describes this pact as 'framing agreement' that includes not only government debt and deficit limits, consequences of abrogating them but also the circumstances under which budget deficits may temporarily exceed Maastricht thresholds. The aim of the SGP, through both police-patrol oversight and sanctions, is to ensure that fiscal policy is conducted in a sustainable manner over economic cycles. Non-compliance with the Pact can in principle lead to sanctions on offending EMU Member States. Countries placed in the so called Excessive Debt Procedure are given a deadline to comply with recommendations of the European Commission. Euro area Member States in non-compliance may face a sanction in the form of a non-interest-bearing deposit of 0.2% of GDP. Further imposition or strengthening of sanctions may take form of a fine of 0.2% of GDP and temporary suspension of financing from Cohesion Funds.

The economic situation in the eurozone focused the attention on the need for proper incentive mechanisms and led to the strengthening of the preventive and corrective arms of the Pact in 2011. Nevertheless, although the majority of countries did not comply with Maastricht criteria before and during the crisis, serious sanctions have never been applied to any Member State. What is more, when the financial crisis evolved into fiscal crisis in the "Periphery" countries, the European Financial Stabilization Mechanism and European Financial Stability Facility offered strong financial assistance to those countries that had breached the fiscal rules.

It seems obvious that such a governance framework is unlikely to provide incentives for fiscal probity, and might in fact be at the root of the current problems of the EMU. At a time when a new mechanism of EU economic governance is being implemented, it is then appropriate to evaluate possible advantages and disadvantages of the new solution. The European Fiscal Pact, which has been ratified by most of the Member Countries, puts into force new and stricter fiscal rules: a 3% limit to the general budget deficit to GDP, 1% for a structural deficit and 60% for debt. Stronger rules assume stricter enforceability of sanctions of breaching the rules. In the new

framework financial penalty for rule-breaking that can amount to 0.1% of countries' GDP. Support to adhere to stricter fiscal rules will be given by the conditionality of the new European Stability Mechanism. EMU Member States that ratified European Fiscal Compact will be eligible for financial support only when obeying fiscal rules.

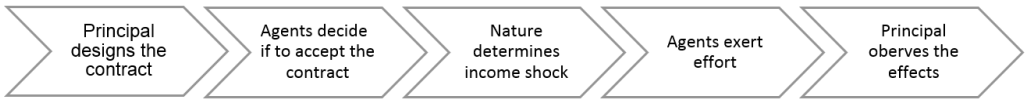
Can this governance framework create a sufficient incentive to reduce imbalances and assure sustainable fiscal policy in the Member States? What is the framework of the contracts that the formal principal-multi agent suggests? Could we benefit from the approach and figure out implementable amendments to the current mechanism?

## 3. The model

### *3.1. Timing scheme and moral hazard*

Our model follows a classical way of representing moral hazard. Informational problems arise here from the fact that after a contract is set, only the agents can observe the state of "nature". As an example, we can think of income shocks randomly experienced by economies. We assume that neither agents nor principal can influence the nature of these idiosyncratic shocks. Because of the information problem and assumption that shocks influence the effort that agents exert, the principal cannot verify directly what action has been performed by agents. We assume that the principal observes only overall state of agents' public finance i.e. the sum of exerted effort and random shocks. The timing scheme of the model is presented below:

Figure 2: Timing scheme of the model




*Source: author's own*

First, the principal - the European Commission - draws contracts for each of two agents: prudent "North" and imprudent "South". Since she does not know what will be the state of the nature, she can only design a contact contingent on the overall future state of public finance. The information she has is imperfect but, since she is aware of the reputation of the agents, it is

not incomplete. The principal knows what might be the influence of shocks and what effects exerted effort may have on public finance. Thus, she may attempt to design a contract that enforces compliance with the desirable effort. In the next step, agents, without knowledge of the future state of their economies, decide if to accept the contract or not. What follows is realization of shocks and, contingent to this, the effort exerted by agents. In the final stage the principal observes the outcome and agents' pays-off.

*3.2. Assumptions*

We assume that there are two types of shocks that may influence each of the agents separately, positive ($\phi^G$) and negative ($\phi^B, \phi^G > \phi^B$). We also presume that desirable effort exerted in a good state ($e_*^G$) is more than the one that is required during the negative shock ($e_*^B$). This assumption reflects counter-cyclicality of fiscal policy, i.e. tightening budgets in sound economic times and loosening them during periods of stress. The overall effect on public finances might be expressed by the equation: $E = e + \phi$. We use classical method of risk-averse agent utility representation - increasing concave utility function ($u'(x) > 0, u''(x) < 0$). Utility of agents is due to rewards given by the principal - the EMU institutions. We assume that utility function has the same form for all of the agents. On the contrary we assume that "bad" agents find it harder to perform effort than "good ones" ($\forall_e v_S(e) > v_N(e)$,$\forall_e v'_S(e) > v'_N(e)$). Not losing generality, other properties of effort function are following: $v'_*(e) > 0$ (increasing) and $v''_*(e) = 0$ (linear).

In the model we employ spill-over effects between economies. These, spillovers either support or hinder effort performed by other agents. They stem from the fact that expansionary fiscal policy equivalent to low fiscal effort generates additional demand in neighboring open economies. That is why, we assume that spill-over effects are an element of effort function of other agents. It is such that: $v_N(e_N, E_S)$ (for agent N) and $v_S(e_S, E_N)$ (for agent S). The effort function is positive on the entire domain, decreasing and linear with respect to observed effort of the other agent. For simplicity, we assume that gains from spill-over effects for particular policy of neighbor country ("country B") are the same no matter what effort "Country A" performs. This is equivalent to: $v_N^{e^N,E^S}(e_N, E_S) = 0$ and $v_S^{e^S,E^N}(e_S, E_N) = 0$

*3.3. The optimal contract*

The problem of the principal is following:

$$\begin{aligned} max\{qp(&e_N^G + \phi^G - w_N^G; e_S^G + \phi^G - w_S^G) \\ &+ (1-q)(1-p)(e_N^B + \phi^B - w_N^B; e_S^G + \phi^B - w_S^B) \\ &+ q(1-p)(e_N^G + \phi^G - w_N^G; e_S^B + \phi^B - w_S^B) \\ &+ p(1-q)(e_N^B + \phi^B - w_N^B; e_S^G + \phi^G - w_S^G)\} \end{aligned} \quad (1)$$

where $q$ and $p$ denote probabilities of positive shocks respectively for the North and South.

The equation says that risk neutral principal wants tom maximize expected economic soundness of both agents having the same share in the maximization function. The equation assumes that agents will apply policy contingent to the expectation of the principal - fiscal effort $e^G$ when shock $\phi^G$ and $e^B$ when $\phi^B$.

The principal must however assure that agents will accept the contract. When deciding whether to sign the contract or not agents will judge by the expectation of their final utility. If it exceeds their reservation utilities, contract will be signed. This constraint might be perceived as a political applicability of the mechanism. Equations describing participation constraint for the North (2) and South (3) take the form:

$$\begin{aligned} qp(u(w_N^G) - v_N(e_N^G, E_S^G)) &+ (1-q)(1-p)(u(w_N^B) - v_N(e_N^B, E_S^B)) \\ + q(1-p)(u(w_N^G) - v_N(e_N^G, E_S^B)) &+ p(1-q)(u(w_N^B) - v_N(e_N^B, E_S^G)) \\ &\geq \bar{U}_N \end{aligned} \quad (2)$$

$$\begin{aligned} qp(u(w_S^G) - v_S(e_S^G, E_N^G)) &+ (1-q)(1-p)(u(w_S^B) - v_S(e_S^B, E_S^B)) \\ + q(1-p)(u(w_S^B) - v_S(e_S^B, E_N^G)) &+ p(1-q)(u(w_S^G) - v_N(e_S^G, E_N^B)) \\ &\geq \bar{U}_S \end{aligned} \quad (3)$$

$\bar{U}_N$ and $\bar{U}_S$ represent respectively reservation utility of the North and South.

As mentioned in the previous section, since agents are rewarded according to the economic situation they face, for some remuneration schemes they

will face incentives to cheat the principal, i.e. to lie about the type of shock they experienced. To be sure of that, the principal must apply incentive compatibility constraints (ICC) in the design of rewards. She must take care of incentives for both agents and for two types of possible shocks. Because of the interdependence of agents, the decision of the agents on which policy to apply (low or high effort) is a game of two. Since agents know their economic situation before they apply policies, it might be perceived as a possibility of four deterministic games for all the possible "nature" outcomes. These games in normal form are presented in Appendix I.

Tables in the Appendix I present payoffs of agents performing particular policies in each of the types of shocks. To be sure that agents would perform the desired policy the principal must assure with her wage scheme Nash equilibrium in N(true)/S(true). Our assumptions however reduce strongly difficulty of the problem. We presumed that spill-overs contribute to agent's policy with the same strength no matter what shock she faces ($v^e_*, E(e, E) = 0$) and that North is more willing to cheat when providing more effort and South for providing it less. We ended up with two (ICC) constraints for each of the agents:

$$u(w^G_{N/S}) - v_{N/S}(e^G_{N/S}, *) \geq u(w^B_{N/S}) - v_{N/S}(e^B_{N/S} - \phi^G + \phi^B, *) \qquad (4)$$

$$u(w^B_{N/S}) - v_{N/S}(e^B_{N/S}, *) \geq u(w^G_{N/S}) - v_{N/S}(e^G_{N/S} + \phi^G - \phi^B, *) \qquad (5)$$

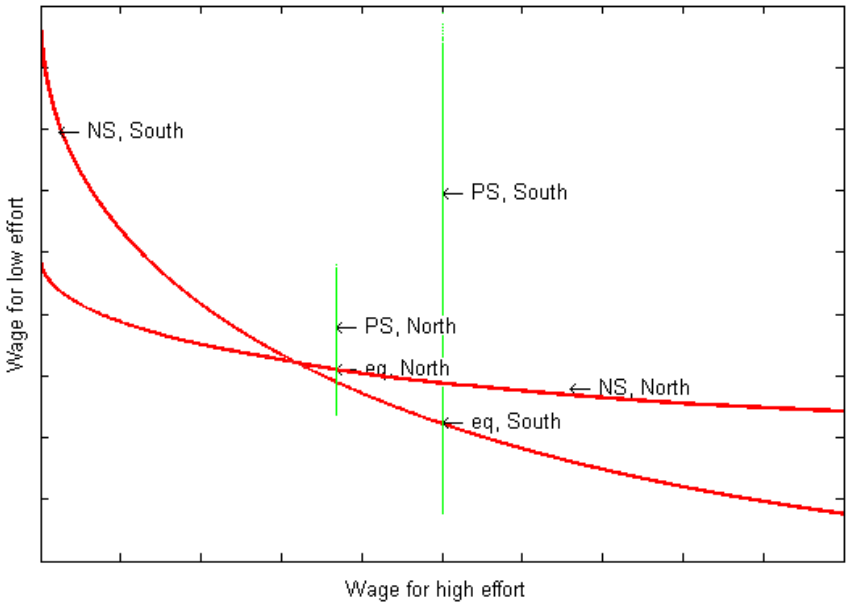
All in all, the optimal contract is a solution to maximization problem with six constrains that could be solved with use of Karush-Kuhn-Tucker conditions (KKT). The set of KKT conditions is presented in Appendix II.

*3.4. Solution*

The problem of finding the optimal contract has one solution, in which only one ICC is binding. The optimal contract must consider binding only the incentive assuring that the South would be willing to exert less effort than the principal requires ($\mu_4 > 0$). Set of equation describing the optimal solution and its explanation is presented in Appendix III.

An illustration of the solution to the problem is presented in Figure 3. $NS$ and $PS$ stand for, respectively, 'negative' and 'positive shock'. These lines show optimal wage for high and low effort in both bad and good economic conditions that optimize utility of the principal. Green lines reflecting optimal contracts for positive shocks are perpendicular to the axis of wage for high effort. Since by assumptions EMU authorities (the principal) are

Figure 3: Illustration of the optimal contract




*Source: own*

**risk neutral** and EMU Member States (the agents) are **risk averse**, without presence of moral hazard red and green lines would be straight as well and perpendicular to red ones. Because of the presence of moral hazard during negative shocks illustrated by red lines wages for different levels of effort negatively depend on each other. This is due to the distortion - necessary incentive that prevents agents from "lying" that they experienced a negative shock. Namely, it would not be optimal for the principal to e.g. simultaneously reduce payment for low effort and not increase for high if he knew that this change would encourage agents to start lying.

At the intersection of these two lines, when wages optimizing behavior in positive and negative shocks are equal, participation and incentive constraints are satisfied and principal utility is optimized. The graphical illustration in Figure 3 presents the case when the same level is required from both agents shows. The coordinates of these points show that 'bad' agents need stronger incentive mechanisms to comply with the rules. In a typical situation, when comparing to North, South receives in a good economic conditions and as less in bad ones. As this creates more incentive for 'bad' agent not to mislead the principal, the difference of wages for a good and low effort is higher for South. Because the graph illustrates only positive rewards for the same effort required, optimal incentive mechanism for a monetary union would have to be different. For the purpose of maintaining a sufficiently strong incentive mechanism and keeping union's budget in track, the principal should penalize for low effort and prize when it is high. Less efficient agents should be subject to more drastic penalties and higher rewards.

## 4. Conclusions and policy implications

In this paper we have addressed the problem of moral hazard among EMU Member States and how it affects required efforts to contain or reduce debt and apply sustainable counter-cyclical fiscal policy. A formal principal-multi agent model that illustrates the current situation in the EMU, shows that there is need for further reform of EU governance. Our investigation shows how the relationship between European Commission and EMU Member States fits very well a simplified principal-multi agent framework. We thus review some of the current European Commissions macroeconomic policies as incentive schemes and surveillance mechanisms. With this approach, we point out some of the reasons for the current problems of the EMU and

contribute to the ongoing debate on the fiscal consolidation and questionable effectiveness of the Stability and Growth Pact.

The formal principal-multi agent analysis of the incentives mechanisms in the EMU suggests that the Member States should be given continuous, strong and credible encouragement to overcome the temptations of moral hazard.

The model shows how valuable information about actual states of individual economies is in the agency framework. Delegation of tasks to agents who have different objectives than the principal is easier to optimize when agents have only different objective functions. If this is the case and agents have no private information, the principal could design a contract which perfectly controls the agent. However, if the agents have private information, designing such contract is no longer possible without loss of efficiency. In the EMU design strong measures should be taken to reduce asymmetry of information between the central and local institutions. This could further development of control and surveillance mechanisms like such as the Macroeconomic Imbalance Procedure.

We also argue that the EU institutions should focus on giving much stronger and more credible incentives to reduce deficits during sound economic times. As the principal-multi agent model shows, the incentives should be executable without delays. At present, the Excessive Debt Procedure and Macroeconomic Imbalance Procedures take very long and hinder punishing countries when such needs appear. Therefore, the current policy is both too weak and time-inconsistent. Strict rules should imply that breaching them must cause direct consequences. Our model suggests that countries that find it more difficult to reduce their debt should be given stronger incentives mechanisms: Member States with higher government debt burdens should be subject to separate incentive schemes. Such incentives would include significantly higher rewards and stronger punishment.

As far as rewards are concerned, preferential loans and guarantees already assumed in the European Stability Mechanism seem to be an efficient solution. When it comes to punishment, the EMU Member States should be subject to financial losses in form of, e.g., EU funds.

In recent years there were several reforms proposed to facilitate the EMU problem of reducing the debt of the Member States. To these kind of solutions belongs e.g. the Blue Bond Proposal by Jakob von Weizsacker and Jacques Delpla in 2010. According to this proposal, sovereign debt in euro area countries is to be split into two parts: guaranteed (blue) and with a

high interest rate burden (red). Overcoming short-term problems is very important, although there is a need to introduce measures which will create stronger incentives to solve the problem in long-term. We claim that that the implementation of efficient, tailor-made incentive schemes would strongly support such necessary solutions focused mostly on short-term.

There are obvious difficulties in implementing our recommendations on tailor-made contracts, first and foremost the cherished principle of equal treatment among EU members. We also keep in mind another problematic issue - difficulty of implementing country-specific solutions. This problem could be solved by negotiations carried out in a similar manner to the negotiations on the EU budget perspectives, but political feasibility and tactics are outside the purview of our paper.

With the model we also arrived to some secondary observations. In Appendix IV we show that it would increase the level of necessary rewards if coordination between North and South was improved (coordination of fiscal policies, stronger common market and interlinkages of economies). In a way economic integration may provoke some group of countries to perform even more expansionary policy than they would perform without integration. The closer will be economies brought together, the more incentives shall be given them to keep their public finance in track.

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## Appendix I

Extensive form of a game between agents when both experience positive shocks:

| | S(true) | S(lie) |
|---|---|---|
| N(true) | $N)\ u(w_N^G) - v_N(e_N^G, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G, E_N^G)$ | $N)\ u(w_N^G) - v_N(e_N^G, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B - \phi^G + \phi^B, E_N^G)$ |
| N(lie) | $N)\ u(w_N^B) - v_N(e_N^B - \phi^G + \phi^B, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G, E_N^B)$ | $N)\ u(w_N^B) - v_N(e_N^B - \phi^G + \phi^B, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B - \phi^G + \phi^B, E_N^B)$ |

A normal form of game between agents when the North faces a negative and the South a positive shock:

| | S(true) | S(lie) |
|---|---|---|
| N(true) | $N)\ u(w_N^B) - v_N(e_N^B, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G, E_N^B)$ | $N)\ u(w_N^B) - v_N(e_N^B, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B - \phi^G + \phi^B, E_N^B)$ |
| N(lie) | $N)\ u(w_N^G) - v_N(e_N^G + \phi^G - \phi^B, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G, E_N^G)$ | $N)\ u(w_N^G) - v_N(e_N^G + \phi^G - \phi^B, E_S^B)$<br>$S)\ u(w_S^G) - v_S(e_S^B - \phi^G + \phi^B, E_N^B)$ |

A normal form game between agents when the North experiences a positive shock, while the South face a negative one:

| | S(true) | S(lie) |
|---|---|---|
| N(true) | $N)\ u(w_N^G) - v_N(e_N^G, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B, E_N^G)$ | $N)\ u(w_N^G) - v_N(e_N^G, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G + \phi^G - \phi^B, E_N^G)$ |
| N(lie) | $N)\ u(w_N^B) - v_N(e_N^B - \phi^G + \phi^B, E_S^B)$<br>$S)\ u(w_S^G) - v_S(e_S^G, E_N^B)$ | $N)\ u(w_N^B) - v_N(e_N^B - \phi^G + \phi^B, E_S^G)$<br>$S)\ u(w_S^B) - v_S(e_S^B + \phi^G - \phi^B, E_N^B)$ |

A normal form game between agents when both are in bad economic situation:

| | S(true) | S(lie) |
|---|---|---|
| N(true) | $N)\ u(w_N^B) - v_N(e_N^B, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B, E_N^B)$ | $N)\ u(w_N^B) - v_N(e_N^B, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G + \phi^G - \phi^B, E_N^B)$ |
| N(lie) | $N)\ u(w_N^G) - v_N(e_N^G + \phi^G - \phi^B, E_S^B)$<br>$S)\ u(w_S^B) - v_S(e_S^B, E_N^G)$ | $N)\ u(w_N^G) - v_N(e_N^G + \phi^G - \phi^B, E_S^G)$<br>$S)\ u(w_S^G) - v_S(e_S^G + \phi^G - \phi^B, E_N^G)$ |

## Appendix II

Karush-Kuhn-Tucker conditions for the optimal contract:

$$(g_1, \mu_1) : -u(w_N^B) + v_N(e_N^B, *) + u(w_N^G) - v_N(e_N^G + \phi^G - \phi^B, *) \leq 0 \quad (6)$$

$$(g_2, \mu_2) : -u(w_S^B) + v_S(e_S^B, *) + u(w_S^G) - v_S(e_S^G + \phi^G - \phi^B, *) \leq 0 \quad (7)$$

$$(g_3, \mu_3) : -u(w_N^G) + v_N(e_N^G, *) + u(w_N^B) - v_N(e_N^B - \phi^G + \phi^B, *) \leq 0 \quad (8)$$

$$(g_4, \mu_4) : -u(w_S^G) + v_S(e_S^G, *) + u(w_S^B) - v_S(e_S^B - \phi^G + \phi^B, *) \leq 0 \quad (9)$$

$$(g_5, \mu_5): \ -qp(u(w_N^G) - v_N(e_N^G, E_S^G)) - (1-q)(1-p)(u(w_N^B) - v_N(e_N^B, E_S^B)) - q(1-p)(u(w_N^G) - v_N(e_N^G, E_S^B)) - p(1-q)(u(w_N^B) - v_N(e_N^B, E_S^G)) + \bar{U}_N \leq 0 \quad (10)$$

$$(g_6, \mu_6): \ -qp(u(w_S^G) - v_S(e_S^G, E_N^G)) - (1-q)(1-p)(u(w_S^B) - v_S(e_S^B, E_S^B)) - q(1-p)(u(w_S^B) - v_S(e_S^B, E_N^G)) - p(1-q)(u(w_S^G) - v_N(e_S^G, E_N^B)) + \bar{U}_S \leq 0 \quad (11)$$

$$\mu_1 \geq 0 \quad (12)$$

$$\mu_2 \geq 0 \quad (13)$$

$$\mu_3 \geq 0 \quad (14)$$

$$\mu_4 \geq 0 \quad (15)$$

$$\mu_5 \geq 0 \quad (16)$$

$$\mu_6 \geq 0 \quad (17)$$

$$g_1(e, w, \phi)\mu_1 = 0 \quad (18)$$

$$g_2(e, w, \phi)\mu_2 = 0 \quad (19)$$

$$g_3(e, w, \phi)\mu_3 = 0 \quad (20)$$

$$g_4(e, w, \phi)\mu_4 = 0 \quad (21)$$

$$g_5(e, w, \phi)\mu_5 = 0 \quad (22)$$

$$g_6(e, w, \phi)\mu_6 = 0 \quad (23)$$

$$\begin{pmatrix} q \\ 1-q \\ -q \\ -(1-q) \\ p \\ 1-p \\ -p \\ -(1-p) \end{pmatrix} + \mu_1 \begin{pmatrix} u'(w_N^G) \\ -u'(w_N^B) \\ -v_N^{e_N^G}(e_N^G + \phi^G - \phi^B, E_S^B) \\ v_N^{e_N^B}(e_N^B, E_S^B) \\ 0 \\ 0 \\ 0 \\ v_S^{e_S^B}(e_N^B, E_S^B) - v_N^{e_S^B}(e_N^G + \phi^G - \phi^B, E_N^G) \end{pmatrix}$$

$$+ \mu_2 \begin{pmatrix} 0 \\ 0 \\ 0 \\ v_S^{e_S^B}(e_S^B, E_N^B) - v_S^{e_N^B}(e_S^G + \phi^G - \phi^B, E_N^B) \\ u'(w_S^G) \\ -u'(w_S^B) \\ -v_s^{e_S^G}(e_S^G + \phi^G - \phi^B, E_N^B) \\ v_s^{e_S^B}(e_S^B, E_N^G) \end{pmatrix}$$

$$+ \mu_3 \begin{pmatrix} u'(w_N^G) \\ -u'(w_N^B) \\ v_N^{e_N^G}(e_N^G, E_S^G) \\ -v_N^{e_N^B}(e_N^B - \phi^G + \phi^B, E_S^B) \\ 0 \\ 0) \\ v_N^{e_S^G}(e_N^G, E_S^G) - v_N^{e_S^G}(e_N^B - \phi^g + \phi^B, E_S^G) \\ 0 \end{pmatrix}$$

$$
+\mu_4\begin{pmatrix}
0\\
0\\
v_S^{e_N^G}(e_S^G,E_N^G)-v_S^{e_N^G}(e_S^B-\phi^G+\phi^B,E_N^G)\\
0\\
-u'(w_S^G)\\
u'(w_S^B)\\
v_S^{e_S^G}(e_S^G,E_N^G)\\
-v_S^{e_S^B}(e_S^B-\phi^G+\phi^B,E_N^G)
\end{pmatrix}
$$

$$
+\mu_5\begin{pmatrix}
-qu'(w_N^G)\\
-(1-q)u'(w_N^B)\\
qpv_N^{e_N^G}(e_N^G,E_S^G)+q(1-p)v_N^{e_N^G}(e_N^G,E_S^B)\\
(1-q)(1-p)v_N^{e_N^B}(e_N^B,E_S^B)+(1-q)pv_N^{e_N^B}(e_N^B,E_S^G)\\
0\\
0\\
qpv_N^{e_S^G}(e_N^G,E_S^G)+(1-q)pv_N^{e_S^G}(e_N^B,E_S^G)\\
(1-q)(1-p)v_N^{e_S^B}(e_N^B,E_S^B)+(1-p)qv_N^{e_S^B}(e_N^G,E_S^B)
\end{pmatrix}
$$

$$
+\mu_6\begin{pmatrix}
0\\
0\\
-qpv_S^{e_N^G}(e_S^G,E_N^G)+q(1-p)v_S^{e_N^G}(e_S^B,E_N^G)\\
(1-q)(1-p)v_S^{e_N^B}(e_S^B,E_N^B)+(1-q)pv_S^{e_N^B}(e_S^G,E_N^B))\\
-pu'(w_S^G)\\
-(1-p)u'(w_S^B)\\
qpv_S^{e_S^G}(e_S^G,E_N^G)+p(1-q)v_S^{e_S^G}(e_S^G,E_N^B)\\
(1-q)(1-p)v_S^{e_S^B}(e_S^B,E_N^B)+(1-p)qv_S^{e_S^B}(e_S^B,E_N^G)
\end{pmatrix}=0 \quad (24)
$$

## Appendix III

We received following set of equations describing the optimal solution:

$$
\begin{aligned}
&(v_N^{e_N}(e_N^B,*)-v_N^{e_N}(e_N^B-\phi^G+\phi^B,*))\left(\frac{q}{u'(w_N^G)}-\frac{q}{u'(w_N^B)}\right)\\
&\qquad+\frac{v_N^{e_N}(e_N^B,*)}{u'(w_N^B)}+\left(p+\frac{(1-p)u'(w_S^G)}{u'(w_S^B)}\right)v_S^{e_N}(*,E_N^G)=1 \quad (25)
\end{aligned}
$$

$$(v_S^{e_S}(e_S^B,*) - v_S^{e_S}(e_S^B - \phi^G + \phi^B,*)) \left(\frac{p}{u'(w_S^G)} - \frac{p}{u'(w_S^B)}\right) + \frac{v_S^{e_S}(e_S^B,*)}{u'(w_S^B)} + \left(q + \frac{(1-q)u'(w_N^G)}{u'(w_N^B)}\right) v_N^{e_S}(*, E_S^G) = 1 \quad (26)$$

$$\frac{v_N^{e_N}(e_N^G,*)}{u'(w_N^G)} + \left(p + \frac{(1-p)u'(w_S^G)}{u'(w_S^B)}\right) v_S^{e_N}(*, E_N^G) = 1 \quad (27)$$

$$\frac{v_S^{e_S}(e_S^G,*)}{u'(w_S^G)} + \left(q + \frac{(1-q)u'(w_N^G)}{u'(w_N^B)}\right) v_N^{e_S}(*, E_S^G) = 1 \quad (28)$$

Equation (25) and (26) describe how much effort should be required from the agents when negative income shock appears. Because all three components of the sum in each of the equations must be positive, we know that $v_{N/S}^{e_{N/S}}(e_{N/S}^B,*) < u'(w_{N/S}^B)$. This inequality shows that the wage of the contract is inefficient with respect to the performed effort. If agents' effort were perfectly verifiable and there were no spill-over effects we would be able to require more effort with lower wage ($v_{N/S}^{e_{N/S}}(e_{N/S}^B,*) = u'(w_{N/S}^B)$). From the equation we conclude that it must be true that the contract is less efficient for the South. The larger the difference between cost of the effort for the agents and probability of positive shocks higher, the less efficient contracts are.

Equations (27) and (28) determine effort of optimal contracts during negative income shocks. For these periods, if there were no spill-overs, contracts would be efficient with respect to the effort. Because of spill-overs we have that $v_{N/S}^{e_{N/S}}(e_{N/S}^G,*) < u'(w_{N/S}^G)$. Thus, the required effort must concern additional disruptions caused by economies dependence. Factor that influences inefficiency of contracts is probabilities of positive shocks. The higher they are, the less effort could be exerted.

## Appendix IV

We show how the optimal solution changes when agents are able to coordinate their actions. We might assume different extent of coordination, which could be seen in the model by agents either:

- sharing common participation constraint,
- sharing common utility and effort function,
- experiencing the same type of shock by both agents (either both agent experience a negative or positive shocks),

- being able to choose Nash equilibrium that maximizes sum of payoffs for both agents.

Bearing in mind that in practice perfect coordination would require transfers of payoffs from one country to another when experiencing different types of shocks, we assume the highest possible extent of coordination. For simplicity we take example in which agents share common participation constraint, utility and effort functions. We assume that either two agents receive a positive shock or a negative one. This is equivalent to the case of principal-single agent version of non-coordination with two possible types of shocks affecting "common" economy. In such case the optimal solution would be:

$$(v'(e^B) - v'(e^B - \phi^G + \phi^B)) \left( \frac{P}{u'(w^G)} - \frac{P}{u'(w^B)} \right) + \frac{v'(e^B, *)}{u'(w^B)} = 1 \quad (29)$$

$$\frac{v'(e^G, *)}{u'(w^G)} = 1 \quad (30)$$

where $P$ stands for probability of a positive shock, $e$ - exerted effort, $\phi$ - income shock and $w$ - payment from the principal for the entire-two countries economy.

In the optimal contract for payment in a good state characterized by equation (30) demanded effort is efficient with respect to common payment. In bad state principal must still require less than efficient common effort. However, comparing to the situation in which economies were treated separately it requires even higher incentives-payments from the principal during both positive and negative shock. This directly stems from the comparison of solutions in non-coordinated and coordinated environment and due to assumption:

$$v'(e) = v_N^{e_N}(e_N, *) + v_S^{e_S}(e_S, *) + v_N^{e_S}(*, E_S) + v_S^{e_N}(*, E_N). \quad (31)$$

Such a mathematical form of coordination could represent a situation in which countries have very close economic relations and condition each other's fiscal policies. Strong economic cooperation might be seen as e.g. strong common market or substantial amount of Foreign Direct Investment. On the other hand, fiscal policy coordination requires political cooperation of ruling governments.