

Nationalekonomiska institutionen



## **A Cup of CAP**

– A Game Theoretic Analysis of the Reform Process of the post-2013  
Common Agricultural Policy of the European Union

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## **Abstract**

This thesis set out with the purpose of analysing the Common Agricultural Policy (CAP) of the European Union (EU) with the purpose of discerning underlying ambitions of decision-makers in order to derive a probable outlook for the post-2013 CAP. With the guidance of a revised edition of the theory of two-level games, a game theoretical approach is used to construct and analyse a dynamic Bayesian game model.

## **Sammanfattning**

Denna uppsats har som syfte att analysera Europeiska Unionens (EUs) allmänna jordbrukspolicy med syfte att utreda beslutsfattares underliggande ambitioner för att på så vis härleda ett troligt utfall gällande jordbrukspolicyns utformning efter 2013. Med vägledning av teorin för dubbel-nivå spel, görs en spelteoretisk ansats för att skapa och analysera en sekventiell Bayesiansk spelmodell.

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# 1 Introduction

Europe's Common Agricultural Policy (CAP) is one of the most controversial and debated elements in the European collaboration. Extensive research has been, and is continuously being, carried out to evaluate the effects of this financially demanding policy program absorbing approximately 40 % of the European Union's (EU's) total budget. Over the years, many results have consistently been pointing towards the need for drastic reform of the CAP in order to make it more efficient, both in terms of true value added within the EU as well as in terms of minimizing disruptive economic effects globally. The CAP has, to some extent, been reformed to satisfy these needs. However, much remains to be done in order to make the policy useful (Zahrnt, 2011b). By 2013 the CAP is due to be reformed (European Commission, 2010b) and so the foundation of any significant change to the CAP is being built today. In order to achieve improvement, it is important to work towards transparency, especially when it comes to the distribution of the large amounts of money that is continuously invested into the beneficiaries of this policy (Zahrnt, 2009).

The purpose of this thesis is to model this political game using the tools provided with game theory, thereby helping to further the understanding of the various parties involved and their underlying motivations and ambitions. As a complement to the mathematical approach of game theory, the theoretical framework of two-level games first presented by Putnam (1988) will be used to add a more holistic touch to the analysis throughout. In the same spirit, not only academic journals are cited, but also communications by EU organs and, occasionally, on-line publications by experts in the field. Through this process this thesis will, hopefully, be able to contribute to the understanding of what is needed to bring about much-needed reforms of the EU's CAP.

Section 2 provides a theoretical overview of the theories and concepts used in this thesis. Section 3 provides a background to the CAP and a light introduction to the context in which decisions are made regarding it. In section 4, game components are defined, including players, and the ordering of the utilities of the players are made. This is then set up as a dynamic Bayesian game which is analysed to give insight into the underlying motivations and ambitions of the players. Section 5 concludes.

## 2 Theoretical Overview

### 2.1 Game Theoretical Concepts

**Dominant strategy:** A dominant strategy is defined as a strategy that yields a higher payoff to a player regardless of what anyone else does in the game. A weakly dominant strategy is a strategy that yields a higher or equal payoff to a player regardless of what other players in the game do.

**Pure strategy:** A pure strategy describes an action that a player will take in any possible decision-point, or node, of the game. In the end, only one strategy will be chosen and a game with only pure strategies are deterministic in the sense that one fixed set of outcomes will emerge.

**Mixed strategy:** A mixed strategy could be described as a strategy set consisting of possible moves linked together with probabilities which tells us how frequently these strategies are to be played. A mixed strategy space denotes the set of all possible mixed strategies for a given player (i.e. all possible probabilities of playing the strategies).

**Nash equilibrium (NE):** A NE is a way to find solutions for strategic games. It's described by a set of played strategies where no player wishes to change strategy unilaterally, i.e. no player has an incentive to change its actions given that no other player does so first.

**Subgame Perfect Nash equilibrium (SPNE):** A subgame perfect Nash equilibrium is a subset of the Nash equilibrium described above (all SPNE are NE but all NE are not SPNE) applying to sequential, or dynamic, games (such as the one modelled in this thesis). In order for an outcome in the game to be classified as a SPNE, it must be a NE in all subgames of that game – meaning that rationally optimum actions, according to the criteria in any NE, must be taken at all decision points in the game leading to the SPNE.

**Backwards induction:** A method of deriving subgame perfect Nash equilibria. Starting at the bottom of the game tree, decide which action is the most desired one for the last player acting. Then assume this player will act that way. Then work your way up the tree to the next player acting before the last player and do the same exercise. Continue all the way up the game tree this way and the strategies that are left are the SPNE. This only works with finite games of full certainty.

**Incomplete information:** Where some information is not available to all players in a game.

**Complete information:** Where all information is available to all players (a criteria of a game of certainty).

**Imperfect information:** Describes a game where some players have imperfect information regarding some other player(s). This is the preferred way to deal with incomplete information first presented by Harsanyi in 1967. By letting an entity not part of the game played ('Nature') assign probability distributions with regards to players being of different 'types', the incomplete information is transformed into imperfect information. Thus players are left to estimate the probabilities of each other player being a certain type.

**Bayesian Nash equilibrium (BNE):** A BNE is defined as a set of strategies for each possible game node and beliefs for each player regarding which type the other players are. This should maximize the expected payoff to each player given the current beliefs about the players' types and the current strategies played by the other players. In other words, in such an equilibrium the action that is chosen by some player P is consistent with what other players think that P chooses, and so on.

## 2.2 Theory of Three-Level Games

The theory of two-level games by Putnam (1988) is used by international relations scholars to more comprehensively understand domestic-international interactions,

taking into account not only domestic causes giving international effects, or vice-versa, but how the different levels affect each other to produce outcomes. Patterson (1997) modified the theory of two-level games by adding a level, making it a three-level game, and adapted it to the EU; making the first level the international arena, the second level the EU arena and the third level the politics at the domestic level. This framework for three-level analysis used by Patterson to analyse the 1988 and 1992 reforms of the CAP will be useful to capture and clarify some of the complexities that decision-makers in the EU face when making decisions. A comprehensive three-level analysis, taking into account international, EU-level and domestic political currents and how these influence each other is not conducted here. However, the concepts and theoretical structure used by Patterson will be applied and referred to throughout.

The mere use of the concepts inherent within this theoretical framework, not applying the theory itself, is useful to be reminded of the vast range of complexities present when analysing political issues – especially transnational ones. It gives a way of putting, for example, the Mercosur trade talks and the WTO's Doha negotiations, the current relations between member states in the EU and the election cycles of individual EU member states into a single, coherent framework. This will prove to be useful when attempting to model the negotiations regarding how the CAP will look after 2013.

**Win set:** Denotes a set of agreements that could be realised by a simple majority vote by the decision-makers involved (Putnam, 1988, p. 437). Thus, if an agreement is to be found it is a requirement that at least some common ground exists. A win set of a particular player can be viewed as a range of agreements that a player could agree to when taking restrictions of national character into account.<sup>1</sup>

**Heterogeneous conflict:** A conflict that is factional, meaning there are internal divisions among decision-makers within the same decision-making organ with regards to an issue. This type of conflicts generally have larger win sets, because “...

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<sup>1</sup>For example, the United Kingdom might have a difficult time accepting a high raise of EU expenditure since this would cause serious political difficulties at home given the strict savings programme recently introduced there. Thus an agreement including raising EU expenditure would not be found in the win set of agreements for the UK.

a government that is internally divided is more likely to be able to strike a deal internationally than one that is firmly committed to a single policy.” (Putnam, 1988, p. 445).

**Level I, Level II and Level III:** Denotes the international political arena, the EU arena and domestic politics, respectively. The three levels influence each other in different ways; a happening on the international arena might well expand or decrease the amount of feasible outcomes at the EU level or even the domestic level. Similarly, level III affairs will in many ways determine what outcomes are feasible at level II and I. Putnam denotes these phenomena ‘reverberations’ and ‘synergistic linkages’ (Putnam, 1988, pp. 447 & 456), but we shall avoid such terminology. For example, if major CAP reform influences a large group of voters in France negatively (level III), it restricts the radical span of the win set of agreements at the EU level (level II). Similarly, if the US together with other countries puts pressure upon the EU to reform the CAP (level I), it restricts the minimalistic span of the win set of agreements (level II).

### 3 Background and Context

**Decision-making in the European Union:** The decision-making processes of the EU are complex. There are several important institutions influencing decisions in various stages of the process. Within these institutions there are different constellations with unique legal mandates. Through this system the agendas of 27 sovereign nation states are driven by their respective representatives.

The rules, procedures and legislative machinery of the EU create a legal framework within which all players are assumed to act. For example, since the Treaty of Lisbon came into effect, the European Parliament (EP) now has the power to reject proposals concerning agricultural matters through the co-decision procedure (European Commission, 2011). The EP is assumed to reject any very radically oriented CAP reform package (Zahrnt, 2011b), which simply means that the span of possible reform packages could be somewhat smaller than before the Lisbon Treaty. This, along with other legislative matters, have no significant impact on the game constructed below. Here it is assumed that these rules and procedures are transparent in

the Union and that member representatives have the same amount of understanding of this system and have equal diplomatic skills. Thus the conclusive factors of EU legislation is assumed to be the political intentions of the member states and the relationships between them. In relation to the CAP, this thesis shall therefore not focus on the legislative procedures of the EU, but rather on the political game. Naturally, the institutions of the EU have amassed power of their own and the European Commission has the power to influence the level II win set of agreements according to, for example, Cavallo et al. (2007). However, to keep the analysis focused it is the nation states that will be considered central. The technical details of applying certain strategies in EU's framework is thus not considered; however, a flow-chart of the various steps of the co-decision procedure, or the 'ordinary legislative procedure' as it is called since the Lisbon Treaty, can be found in appendix A.

It is also important to acknowledge that the formation of the CAP is just one of many variables decision-makers consider. The uncertainties regarding what exactly these variables are and their respective impacts on decisions regarding the CAP cannot be underestimated. Any player wanting to impact the future of the CAP policy package in a certain way may 'trade' that ambition, in a political sense, for something viewed as more important. Zahrnt (2011b) acknowledges this opportunity for trade (on p. 23) by concluding that "... the tectonic shifts in the EU polity ... may cement the CAP or tear it apart." Moreover, in most political negotiations, many coalitions between a myriad of possible players consisting of corporations, NGOs, political factions, various decision-makers, et cetera, exist. To fully analyse each and every position and coalition possible and their impact on CAP reform, using, for example, a very extensive method such as the one illustrated by de Mesquita (1984), is out of the scope of this thesis.<sup>2</sup>

**Background to the Common Agricultural Policy:** Before the industrial revolution started in the first half of the 19<sup>th</sup> century, agriculture in Europe was not laden with tariffs and policy packages such as the CAP. The ease of transport along with the massive migration of labour from agriculture into the growing industrial sector

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<sup>2</sup>Bruce Bueno de Mesquita is a game theorist known to predict outcomes of political negotiations with extra-ordinary accuracy using an expected utility approach involving computer simulations. See also Saaty (1979) for a highly structured way of generating game elements.

pressed decision-makers in Europe to take some protectionist measures by the end of the 19<sup>th</sup> century. This trend continued and tariffs and other protectionist trade policies continued to grow slowly in Europe. However, they were increased greatly following World War I and by the time World War II ended, these policy packages had been developed and enhanced into what was the birth of the Common Agricultural Policy of the European Economic Community in 1958. The CAP was a child of its time.

The above recollection is taken from Bullock and Mittenzwei (2005). Bullock and Mittenzwei argue that the CAP is still with us today because of institutional inertia.<sup>3</sup> The time before and after WWII shocked the agricultural policies of Europe (and the US) into a situation where the CAP was first created. They argue that the EU since this shock have been in a ‘political economic equilibrium’, with regards to agricultural policy, where farmers make large political payments and are not met with similar engagement from non-farmers. They argue that such shocks can stay in place for a long time (but, implicitly, not forever). The overall development of the CAP during the past two decades has been towards less market distortion and protectionism. Bullock and Mittenzwei have, using evolutionary game theory, convincingly argued that the CAP policy package is on it’s last, but slow, trip towards disappearing completely. Any serious attempt at ‘reverse’ CAP reform, such that the policy package would take a protectionist turn or get increased budget allocations, can be considered highly unlikely. Especially so because of the absence of any serious indications in that direction by the European Parliament or the Commission (European Parliament, 2011; European Commission, 2010a).<sup>4</sup>

Perhaps the issue of the CAP will be solved in due time. Meanwhile, let us go through the basics of the CAP as it looks like today. Currently, the CAP is not as trade distorting or harmful as it has been historically – it can better be described as wasteful (Zahrnt, 2011b). In 1992, price interventions were slowly transformed into production subsidies. These lead farmers to produce great volumes of agricultural

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<sup>3</sup>Meaning, institutions are slow to adapt and, just like big vehicles, take time to steer to a new directions.

<sup>4</sup>It should be noted here that even though the Commission has produced official communications on the topic outlining possible reform alternatives, they have yet to produce an actual legislative proposal. This is due to happen in June/July 2011 and its contents will thus not be considered in this thesis.

goods in order to get subsidies instead of meeting market demand. In 2003, the production subsidies were increasingly replaced by direct income support to farmers (called Single Farm Payments). That Single Farm Payments (SFPs) are wasteful and should be removed have been a common position among economists and others for quite some time. Payments should instead be linked to various community services and providing certain public goods, such as improving the environment and keeping rural landscapes alive (Brady et al., 2008). The current reform alternatives on the agenda is what could be called a status-quo, or minimalistic reform level, a gradual, or successive reform level, and a more liberally, ‘radically’ inclined reform level (European Commission, 2010b,a; Zahrnt, 2009; European Parliament, 2011).

According to Patterson (1997), the previous CAP reforms that mattered were the result of a mix of pressure from several political levels that expanded the win set of the decision-makers present at the time. The analysis below maps up the main stand-points and stakes and make an attempt at modelling a Bayesian game using assumptions with the added benefit of a holistic, politically multilayered approach.

## **4 Analysis**

The game shown below is meant to be a representation of a simple voting procedure. Players are thought to be able to take one of two positions: they can either ‘campaign for a cause’ or ‘vote’. As in any voting procedure, the job of the campaigning players is to convince the voting players to support them instead of the opposition. The job of the voting players, on the other hand, is to seek to maximize their own utility by ‘selling’ their vote on the political arena as ‘expensively’ as possible and then, of course, vote. The game below is thus sequential, where the campaigners choose their strategies – not knowing with full certainty how the voters will vote or what the strategy of the other campaigners will be – and voters then vote afterwards with the full knowledge of what strategies the campaigners played. Since the CAP has been around in some form since 1958, one might argue that a model of repeated games would be more accurately describe the real outcome of this reform process. Here it is considered enough to model the current reform process as a one-shot game while drawing upon studies taking into account several negotiation rounds to strengthen assumptions. This approach, in all its simplicity, still yields rewarding

and enlightening results.

There are three main reasons why a sequential game like the one described fits the problem of describing the CAP reform process. First, in the context of the EU, especially when it comes to the CAP, consensus is an important feature and it is unlikely that any member state would want to simply ‘leave the table’. Changes to the CAP have traditionally taken place with unanimity even though a qualified majority would have been enough under the Treaty of Rome (Keeler, 1996, p. 136). Moreover, the agreement of having a Single Market in the EU (or the EU at all, for that matter), rests upon the member states’ willingness to drive questions to their end and struggle to find necessary compromises. Leaving the negotiation table would thus not only hurt the member state doing so, but it would damage the image of the collaboration as a whole (Cavallo et al., 2007, p. 6), arguably both inside and outside of the EU. Therefore it is considered highly unlikely that an outcome without an agreement will be allowed. The game will thus ‘finish’ in one of the outcomes in described the model. Second, the aim of the campaigners is to, as favourably as possible, eliminate uncertainty with regards to how voters align themselves before the vote takes place. This behaviour is captured in a sequential game where campaigners first play their strategies and voters then decide whom to support. Third, the way that EU legislature is set up, it seems natural to use a sequential model to describe it. See appendix A for a brief overview.

Naturally, creating a game of this sort requires rough simplifications and will capture but a fraction of all aspects of reality when it comes to this kind of complex decision-making. The value of such an approach is that a very complex situation is reasonably simplified into something that is possible to analyse and yet still contains key aspects of the decision-making. This helps us to sift away everything but the most important parts of the decision-making. To this end, many, duly motivated, simplifications, will be made below.

## **4.1 Players**

As stated previously there are three clear CAP reform alternatives on the agenda. Naturally, ‘teams’ of member states, or groups with similar level III win sets, will form to more effectively drive through desired reform packages. Drawing upon

Zahrnt (2011b) and Gooch (2010), the following teams can be constructed. The status-quo, or bare-minimum, reform level is driven, or campaigned, primarily by France with the clear backing of Italy, Spain, Ireland and Greece. Similarly, the clearly liberal, or ‘radical’, CAP reform packages are campaigned primarily by the United Kingdom supported by the Netherlands, Sweden, Denmark and Malta. Other member states can be considered to have no such clear-cut positions either for or against CAP reform – though of course some member states could be somewhat more reform oriented or slightly against reform. Zahrnt (2011b) notes some more constellations or groups with similar interests, or member states who could possibly also be construed as a campaigners (among them Poland and the new member states). However, for simplicity’s sake, we will let Germany represent all other member states who are neither ‘with the French’ or ‘with the British’, i.e. the member states with broader level III win sets.

The picking of Germany for this role can be motivated as follows. Even if, for example, the new member states represent a large chunk of the total population of the EU (and control a significant portion of the votes), it is assumed to be considered better, in terms of achieving the desired CAP reform, to win over Germany – simply because Germany is more powerful and can be considered to have a far more deterministic influence on the outcome of the CAP reform package than other member states. As an example, in 2009, the GDP of Poland, Romania, Hungary, Estonia, the Czech Republic, Slovakia, Bulgaria, Cyprus, Latvia and Lithuania *put together* roughly equalled only one-third of Germany’s GDP (World Bank, 2011).<sup>5</sup>

The game below thus consists of three players: ‘France’, ‘Germany’ and ‘the United Kingdom’. Though these players represent ‘teams’ of countries, the analysis of the game will focus on the two campaigners, France and the UK, and Germany for the sake of simplicity.<sup>6</sup> France will henceforth be denoted with  $F$ , Germany with  $G$  and the United Kingdom with  $U$ .

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<sup>5</sup>For an enlightening illustration of how Germany’s broader win set could make it support both more radically inclined reform packages as well as more minimalistic versions, see Cavallo et al. (2007, p. 8).

<sup>6</sup>These member states could also be considered the most relevant to analyse for reasons analogous to the ones motivating the ‘picking of Germany’ in the previous paragraph.

## 4.2 Strategies

Taking the above into account, the UK can be considered a ‘campaigner’ driving a radical reform level, France can be considered a ‘campaigner’ driving a minimalistic reform level while Germany can be considered to be a ‘voter’. In this section, this viewpoint is strengthened and will prove a good basis for defining realistic strategies for the players. Since constructing strategies like this also touches upon the utilities of the players since any player designs strategies to begin with in order to maximise its expected utility. It thus seems natural to also include here much of the motivations for the players’ utilities in this section, though the formalisation and ordering of the utilities and payoffs of the players is left to a section of its own.

**The United Kingdom ( $U$ ):** It is clear that the level III win set of agreements for this player is more on the radical side for several reasons (Zahrnt, 2011b; Cavallo et al., 2007; Gooch, 2010). Politically, it would be hard for the UK to motivate being gentle on the CAP while at the same time introducing such tight savings packages at home, for example. A more minimalistic reform level can reasonably be considered out of the UK’s win set of agreements. Still, there is some doubt with regards to the UK’s real commitment to wipe out the CAP entirely. The UK receives a hefty sum of money just because the CAP is a large part of the EU budget (Zahrnt, 2011b). The special budget rebate was demanded by Margaret Thatcher in 1984 because the UK received less relative benefit from the CAP compared to other countries (Thurston, 2010b). Hence if the CAP disappears, it will be harder for the UK to motivate keeping the rebate. This dimension is not considered important enough to influence the UK too much, however, but can instead be seen as a consolation prize in case the level of CAP reform turns out to be negligible.

Though a quite wide range of agreements may still be possible for the UK, let us assume, for simplicity’s sake, that the UK can play the strategy of campaigning for a radical reform level or play the strategy of campaigning for a more successive reform level. If the radical approach appears hopeless, it is still better for the UK to push for a successive reform level with the hopes of more reform down the line than to accept a minimalistic reform level. We denote the strategy to campaign for a successive reform level with  $c_S^U$ , and campaigning for a radical reform level with

$c_R^U$ .

**France (F):** Similarly to the UK, the level III win set of agreements of France is limited, though in the other direction. In 2009, the amount of people employed in the agricultural sector (including hunting, forestry and fishing) in France is estimated to 752,000 individuals (Eurostat, 2009). Adding individuals working in industries related to the agricultural sector, that number could be expected to grow quite a bit. All in all, however, the share of people employed in the agricultural or related sectors remains small when compared to the rest of the population. However, farmers have tight connections with rural areas in general and upsetting this group could significantly lessen the amount of votes from larger rural regions (Nedergaard, 2006). Nedergaard further states that the European farm lobby has, for a number of beneficial organisational reasons, become unusually potent and influential in Europe despite the fact that they represent but a fraction of the total population. This is partly due to the fact that taxpayers, who could oppose the farm lobby, face low marginal benefits for doing so while farmers face huge marginal benefits for lobbying. Clasper and Thurston (2010) estimates individual taxpayer losses due to the CAP to around €10/year and, quite strikingly, compare this amount to the gains of some €700,000/year for certain individual farmers. Moreover, the transparency of the subsidies still leave much to be desired which serves to increase the cost for taxpayer engagement (Thurston, 2009a; Thurston et al., 2011). This phenomena is also discussed briefly section 2.

This, coupled with the farm lobby's significant ability to influence public awareness, makes it important for any politician ruling for the rural vote to be friendly towards farmers – in spite of their dwindling numbers (European Commission, 2010c). The next public election in France takes place in 2012 and it is doubtful whether the French government lead by president Sarkozy will risk upsetting rural voters. It looks like we can safely exclude a radical reform level from France's level III win set of agreements. Zahrnt (2011b) adds, however, that there has been some internal disputes within the French government with regards to the CAP, which is also noted by Thurston (2010a). This could indicate that the issue is taking a somewhat more heterogeneous character in France. Moreover, with the entry of the new member states, France is slowly becoming a net contributor to the CAP instead of

net gainer (Thurston, 2009b). These factors might be signs that the French win set, although certainly in the conservative span, might not be narrow in the extreme.

For simplicity's sake, we make the assumption that France can play the strategy to campaign for a minimal reform level, denoted by  $c_M^F$ , but also the strategy to campaign for a successive reform level, denoted by  $c_S^F$ .

**Germany ( $G$ ):** Germany's strategies are straightforwardly derived from the discussions and assumptions above. Germany is assumed to be able to play two strategies, one where France's cause is supported, or 'voted for', and one where the UK's cause is voted for. Germany's strategy of voting for France is denoted by  $v_F^G$  and the strategy voting for the UK is denoted by  $v_U^G$ .

**A summary of the strategies and adding some notation:** To summarize, the UK had the two strategies 'campaign for successive reform' and 'campaign for radical reform'. France had the two strategies 'campaign for successive reform' and 'campaign for minimal reform'. Germany had the two strategies 'vote for France' and 'vote for the UK'. If we let a 'strategy' be denoted by STR and with the player notations in superscript, we can sum up the strategies of the players in the following way:

$$STR^U \in \{c_S^U, c_R^U\}$$

$$STR^F \in \{c_S^F, c_M^F\}$$

$$STR^G \in \{v_F^G, v_U^G\}.$$

Further, let  $\alpha$  be the probability that France assigns to the UK choosing  $c_S^U$  and let  $\beta$  be the probability that the UK assigns to France choosing  $c_M^F$ . Now let  $\gamma$  denote the probability that France and the UK assign to Germany choosing  $v_F^G$  if France chooses  $c_M^F$  and the UK chooses  $c_S^U$ . Where France chooses  $c_S^F$  and the UK chooses  $c_R^U$ , France chooses  $c_M^F$  and the UK chooses  $c_R^U$  and finally when France chooses  $c_S^F$  and the UK chooses  $c_S^U$  we can denote the probability that the two players assign to Germany choosing  $v_F^G$  by  $\delta$ ,  $\lambda$  and  $\zeta$ , respectively. Because the probabilities all lie between zero and one, that is  $\alpha, \beta, \gamma, \delta, \lambda, \zeta \in [0, 1]$ , the probability for the respective 'opposite action' is simply  $1 - \alpha$ ,  $1 - \beta$ , et cetera. As shall be seen below, we will only be concerned with  $\gamma$  when it comes to the uncertainties of Germany's

actions. Then the mixed-strategy space for each of the players, which denotes the possible range of probabilities each of the players can choose to play their strategies with, can be denoted as follows. For the UK, it is  $\rho_U = (\alpha, 1 - \alpha)$ , for France it is  $\rho_F = (\beta, 1 - \beta)$  and for Germany it is  $\rho_G = (\gamma, 1 - \gamma)$ . Below a reference-like list of notations is available for the purpose of keeping the notation clear to the reader while reading the text.

- The UK, ( $U$ ), plays *campaign for radical reform*,  $c_R^U$ , with probability  $\alpha$  and plays ‘campaign for successive reform’,  $c_S^U$ , with probability  $1 - \alpha$  yielding the mixed strategy space  $\rho_U = (\alpha, 1 - \alpha)$ .
- France, ( $F$ ), plays *campaign for minimal reform*,  $c_M^F$ , with probability  $\beta$  and plays ‘campaign for successive reform’,  $c_S^F$ , with probability  $1 - \beta$  yielding the mixed strategy space  $\rho_F = (\beta, 1 - \beta)$ .
- Germany, ( $G$ ), plays *vote for France*,  $v_F^G$ , with probabilities  $\gamma, \delta, \lambda$  and  $\zeta$  and *vote for the UK*,  $v_U^G$ , with probabilities  $1 - \gamma, 1 - \delta, 1 - \lambda$  and  $1 - \zeta$  for the different strategy combinations of the France and the UK. Taking into account only  $\gamma$ , the following mixed strategy space can be seen  $\rho_G = (\gamma, 1 - \gamma)$ .

If this notation seem confusing, the game tree below should make it easier for the reader to visualize what is described here and can refer back to this section for clarifications.<sup>7</sup>

### 4.3 Possible Game Outcomes

The CAP is a multifaceted policy package and there are uncountable ways of changing parts of it, rephrasing policies, et cetera. Should one limit the possible agreements to a specific span of agreements that overlap with the players’ level III win sets, it might be possible to reduce width of reasonable outcomes. However, a very fine scale would be required to give an accurate account of the real possible reform outcomes. Here, rough simplifications are made that correspond to the players’

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<sup>7</sup>For readers unfamiliar with Greek, the following signs are used:  $\alpha$  pronounced ‘al-fa’,  $\beta$  pronounced ‘be-ta’,  $\gamma$  pronounced ‘gam-ma’,  $\zeta$  pronounced ‘se-ta’,  $\lambda$  pronounced ‘lamb-da’, pronounced ‘rowh’.

strategies, but they will still allow us to capture the most relevant span of reform outcomes.

If France and the UK both choose to campaign for a successive reform outcome (playing  $c_S^F$  and  $c_S^U$ , respectively), then the outcome of the CAP reform will be considered to take the shape of a successive agreement denoted by  $S$  – no matter whom Germany decides to vote for. However, having Germany as a supporter or not might of course influence the utilities of France and the UK. We will therefore denote the case where  $S$  is the outcome and Germany supports the UK with  $S_U$  and where Germany supports France with  $S_F$ . Now, if France chooses the strategy  $c_M^F$  and the UK chooses the strategy  $c_S^U$ , then if Germany chooses the strategy  $v_U^G$  we will again end up with the outcome  $S_U$ . Though if Germany instead plays  $v_F^G$  then the outcome will be a minimal reform level denoted by  $M$ . Similarly, if the UK plays strategy  $c_R^U$  and France plays  $c_M^F$  then Germany chooses between a radical reform outcome, denoted by  $R$ , or  $M$  by playing  $v_U^G$  or  $v_F^G$ , respectively. In short:

- If  $F$  plays  $c_S^F$  and  $U$  plays  $c_S^U$ , we get the outcomes  $S_F$  or  $S_U$  depending on whether  $G$  plays  $v_F^G$  or  $v_U^G$ .
- If  $F$  plays  $c_M^F$  and  $U$  plays  $c_S^U$ , we get the outcomes  $M$  or  $S_U$  depending on whether  $G$  plays  $v_F^G$  or  $v_U^G$ .
- If  $F$  plays  $c_S^F$  and  $U$  plays  $c_R^U$ , we get the outcomes  $S_F$  or  $R$  depending on whether  $G$  plays  $v_F^G$  or  $v_U^G$ .
- Finally, if  $F$  plays  $c_M^F$  and  $U$  plays  $c_R^U$ , we get the outcomes  $M$  or  $R$  depending on whether  $G$  plays  $v_F^G$  or  $v_U^G$ .

The game has the four unique outcomes  $M$ ,  $R$ ,  $S_F$  and  $S_U$ .

#### 4.4 Payoffs

It is hard, if not impossible, to assign absolute values to the utilities of the players with regards to the different outcomes. Instead, we order the outcomes based on utilities and assign payoffs thereafter. We denote the payoffs of the United Kingdom with  $U_i$ , of France with  $F_j$  and of Germany with  $G_k$  where  $i, j, k \in 1, 2, 3, 4$ . We let a lower index denote higher payoff; for example, France's payoff with regards to its

most desired outcome is denoted by  $F_1$ . Similarly, France's lowest payoff is denoted by  $F_4$ . More formally:

$$F_1 \geq F_2 \geq F_3 \geq F_4$$

$$U_1 \geq U_2 \geq U_3 \geq U_4$$

$$G_1 \geq G_2 \geq G_3 \geq G_4.$$

The payoff  $P$  of any player can be described by a utility function  $P(A, B, C)$  of the three players' strategy choices since the payoff is directly derived from the players' utilities. That is, for France's strategy choice  $A \in \{c_M^F, c_S^F\}$ , the UK's strategy choice  $B \in \{c_S^U, c_R^U\}$  and Germany's strategy choice  $C \in \{v_F^G, v_U^G\}$ . For example, assume France's most desired outcome is  $M$ , which means that France's payoff in this outcome is  $F_1$ . The outcome  $M$  can also be described by the strategy sets producing this outcome:  $(c_M^F, c_S^U, v_F^G)$  and  $(c_M^F, c_R^U, v_F^G)$ , since if Germany supports France and France plays  $c_M^F$  then the minimalistic reform outcome will be produced for every strategy that the UK plays. Thus the payoff  $F_1$  received by France can be written equivalently as  $P^F(c_M^F, c_S^U, v_F^G) \sim P^F(c_M^F, c_R^U, v_F^G)$ .<sup>8</sup>

Let us now point out that due to the high pressure to reach agreements described earlier, the utilities constructed here do not necessarily correlate well with reality when viewing things from an EU-wide or nation-wide perspective. Member states receiving a low utility in this issue of the CAP could (or, more probably, will) be compensated in other areas due to the damage incurred if a member becomes indignified enough to leave the negotiation table. Thus, an agreement where one of the players is over-ruled on the issue of CAP reform may well be in the win set of agreements at the EU level – simply because that player in all likelihood receives something else in compensation. Since only the CAP is modelled here, this compensation cannot be taken into consideration. Though the utilities should be reasonably accurate in terms of this particular policy question when isolated.

**The United Kingdom (U):** Drawing upon the discussions above where we defined player strategies, the UK clearly prefers a radical reform outcome  $R$  to a minimalistic one  $M$ . The UK should also prefer a successive outcome to a minimal

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<sup>8</sup>The symbol  $\sim$ , called a similarity sign, tells us that the two payoffs are similar to each other.

one. Moreover, the UK prefers a successive reform outcome when supported by Germany  $S_U$  to a successive reform outcome when France was supported  $S_F$ . We also assume that a radical reform outcome  $R$  is preferred to any gradually oriented reform outcome  $S_U, S_F$ . We can compile this reasoning as an ordered list of the UK's payoffs.<sup>9</sup> The reason for also including the utility functions is for the reader to easily see which set of strategies yield the corresponding outcomes.

1. The radical reform outcome,  $R$ , yields the highest payoff,  $U_1$ , which corresponds to the utility functions

$$P^U(c_S^F, c_R^U, v_U^G) \sim P^U(c_M^F, c_R^U, v_U^G).$$

2. The successive reform outcome where Germany supports the UK,  $S_U$ , yields the second best payoff  $U_2$ , which corresponds to the utility functions

$$P^U(c_S^F, c_S^U, v_U^G) \sim P^U(c_M^F, c_S^U, v_U^G).$$

3. The successive reform outcome where Germany supports France,  $S_F$ , yields the second worst payoff  $U_3$ , which corresponds to the utility functions

$$P^U(c_S^F, c_S^U, v_F^G) \sim P^U(c_S^F, c_R^U, v_F^G).$$

4. The minimal reform outcome,  $M$ , yields the lowest payoff,  $U_4$ , which corresponds to the utility functions

$$P^U(c_M^F, c_S^U, v_F^G) \sim P^U(c_M^F, c_R^U, v_F^G).$$

**France ( $F$ ):** The level III win set of agreements for France seem fairly adverse to the win set of the UK. First, we can conclude that a minimalistic level of reform  $M$  is clearly preferred by France – especially when also considering the supporters of France (Italy, Spain, Ireland and Greece) who can all be assumed to have win sets in the strictly conservative span (Cavallo et al., 2007; Zahrnt, 2011b). Second, we can conclude that a radical reform level  $R$  is clearly out of the French win set due to the reasons mentioned above. Furthermore, we can safely assume that France will be better off if supported by Germany if a successive reform outcome should prevail. We can summarise the French ordering of payoffs as follows.

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<sup>9</sup>Here, prestige is not considered a factor. I.e., the UK is not considered to receive a higher utility when pushing through a radical reform outcome  $R$  if France is working for the exact opposite outcome by playing  $c_M^F$ , vis-à-vis should France play  $c_S^F$ .

1. The minimal reform outcome,  $M$ , yields the highest payoff for France,  $F_1$ , which corresponds to the utility functions  $P^F(c_M^F, c_S^U, v_F^G) \sim P^F(c_M^F, c_R^U, v_F^G)$ .
2. The successive reform outcome where Germany supports France  $S_F$  yields the second best payoff,  $F_2$ , which corresponds to the utility functions  $P^F(c_S^F, c_S^U, v_F^G) \sim P^U(c_S^F, c_R^U, v_F^G)$ .
3. The successive reform outcome where Germany supports the UK,  $S_U$ , yields the second worst payoff,  $F_3$ , which corresponds to the utility functions  $P^F(c_S^F, c_S^U, v_U^G) \sim P^U(c_M^F, c_S^U, v_U^G)$ .
4. The maximal reform outcome,  $R$ , yields the lowest payoff to France,  $F_4$ , which corresponds to the utility functions  $P^F(c_M^F, c_R^U, v_U^G) \sim P^U(c_S^F, c_R^U, v_U^G)$ .

As the observant reader now notices, the utilities of France and the UK is perfectly antisymmetric.

**Germany ( $G$ ):** Germany is the player with the widest level III win set among the three and is considered to be able to ‘swing either way’. However, France and Germany have a history of deep and intense collaboration, especially in EU-related issues. The German Foreign Office (2011) states that “France is Germany’s closest and most important partner in Europe. With no other country does it coordinate all its policies more extensively or regularly.” On the other hand, when it comes to the UK, the same authority states that “Germany and the United Kingdom have close and wide-ranging relations based on mutual trust. There are practically no bilateral problems of note.” Naturally, many other issues may weigh in and this is a rough way of determining preferences – but given all else equal, we can more or less safely assume that Germany would prefer to support France. Moreover, differences on tough issues, such as the one of fiscal discipline in the EU, are overcome and the two member states are even referred to as the ‘Franco-German motor’ of European integration (Breidhardt and Barkin, 2011). It seems quite unlikely that the Germany would support the UK if France campaigned for a minimalistic reform level and the UK campaigned for a radical reform level.

However, due to the recent economic debacles in Europe, Germany has introduced tight savings packages at home. This has caused massive protests and induced feelings of injustice and anger among German voters (Marsh, 2010; Horn and Hüther, 2010). Similarly to the UK, it might be politically painful to allow spending at the EU level and at the same time motivating such savings at home. According to Zahrnt (2011b), the official German position is still highly conservative with regards to the CAP, though he points out that most decision-makers would value an ambitious reform package and Germany do drive the issue of fiscal discipline in the EU at large. Moreover, Germany is in a net payer position in the EU (meaning Germany pays more to the community than it receives) and this position may deteriorate further after 2014 if nothing is done (“Cameron Rallies Troops”, 2010), indicating further financial pressure upon Germany. These differing viewpoints not only make the level III win set for Germany so wide and it also makes Germany’s preferences less obvious than those of the UK and France.

In order to reflect this uncertainty regarding Germany’s preferences, we will apply the theory presented in 1967 and 1968 by the Hungarian mathematician Harsányi János Károly (known popularly as John Harsanyi). For further explanation of this method, see section two. We will assume that France and the UK is somewhat uncertain with regards to the preferences of Germany and that they will assign two ‘types’ to Germany representing the differences in preferences. The first type we call ‘normal’ and will denote by  $G^n$  while the second type we will call ‘pressured’ and denote by  $G^p$ . If Germany is type ‘normal’, we will assume that Germany would support France no matter what, though in all likelihood Germany would prefer a more successive reform level than a minimalistic one but not enough to break with France. While, if Germany is type ‘pressured’, we will assume that Germany will break with France to push through a successive reform level instead of a minimalistic one. That Germany would vote for a radical reform alternative when France is campaigning for a minimalistic one is considered too drastic a development to be taken seriously considering the tight relationship between the two countries. We summarise this below.

**The payoffs of Germany when type ‘normal’.** Germany supports France in all cases but would prefer if a successive reform alternative won.

1. The successive reform outcome where Germany supports France  $S_F$  yields the best payoff  $G_1^n$ , which corresponds to the utility functions  $P^{G^n}(c_S^F, c_S^U, v_F^G) \sim (P^{G^n}(c_S^F, c_R^U, v_F^G))$ .
2. The minimal reform outcome,  $M$ , yields the second best payoff,  $G_2^n$ , which corresponds to the utility functions  $(P^{G^n}(c_M^F, c_S^U, v_F^G) \sim P^F(c_M^F, c_R^U, v_F^G))$ .
3. The successive reform outcome where Germany supports the UK,  $S_U$ , yields the second worst payoff,  $G_3^n$ , which corresponds to the utility functions  $P^{G^n}(c_S^F, c_S^U, v_U^G) \sim P^U(c_M^F, c_S^U, v_U^G)$ .
4. The maximal reform outcome,  $R$ , yields the lowest payoff to the normal type Germany,  $G_4^n$ , which corresponds to the utility functions  $P^{G^n}(c_M^F, c_R^U, v_U^G) \sim P^U(c_S^F, c_R^U, v_U^G)$ .

**The payoffs of Germany when type ‘pressured’.** Germany supports France in most cases, but supports the UK instead if it can reach a successive reform outcome. Changes to the ordering of the payoffs are marked with a star.

1. The successive reform outcome where Germany supports France,  $S_F$ , yields the best payoff,  $G_1^p$ , which corresponds to the utility functions  $(P^{G^p}(c_S^F, c_S^U, v_F^G) \sim (P^{G^n}(c_S^F, c_R^U, v_F^G))$ .
2. The successive reform outcome where Germany supports the UK  $S_U$  yields the second best payoff,  $G_2^p$ , which corresponds to the utility functions  $(P^{G^p}(c_S^F, c_S^U, v_U^G) \sim (P^U(c_M^F, c_S^U, v_U^G)).*$
3. The minimal reform outcome,  $M$ , yields the second worst payoff,  $G_3^p$ , which corresponds to the utility functions  $(P^{G^p}(c_M^F, c_S^U, v_F^G) \sim (P^F(c_M^F, c_R^U, v_F^G)).*$
4. The maximal reform outcome,  $R$ , yields the lowest payoff to the pressured type Germany,  $G_4^p$ , which corresponds to the utility functions  $(P^{G^p}(c_M^F, c_R^U, v_U^G) \sim (P^U(c_S^F, c_R^U, v_U^G))$ .

The UK and France do not know which state Germany is in when choosing their strategies and thus assigns a probability,  $\gamma$  to Germany being type ‘normal’ and  $1 - \gamma$  to Germany being type ‘pressured’. The reader will note that this  $\gamma$  is the

same probability assigned to Germany by France and the UK for choosing to vote for France when France campaigns for a minimalistic reform level and the UK campaigns for a successive reform level. The only change with regards to Germany's preferences when 'changing types' is that this player will make a different decision when France and the UK plays exactly these strategies. Thus the probability assigned in this case by the France and the UK that Germany chooses this strategy should be just equal to the probability assigned to Germany being type 'normal' or type 'pressured'. In other words: When  $F$  plays  $c_M^F$  and  $U$  plays  $c_S^F$ ,  $G^n$  will play  $v_F^G$  yielding payoff  $G_2^n$  since  $v_U^G$  in this case would only yield  $G_3^n$ . However,  $G^p$  would in the same situation play  $v_U^G$  yielding payoff  $G_2^p$  since now it is the strategy  $v_F^G$  that yields the lower payoff  $G_3^p$ . This is because Germany in a financially pressured state prefers the successive reform outcome proposed by the UK instead of supporting France (which Germany prefers in the normal state).

We assume for simplicity's sake that the uncertainty described here is the only uncertainty with regards to Germany's preferences and that France and the UK is otherwise fully aware of how Germany will act all other situations. Thus  $\lambda = \zeta = \delta = 1$  and our only concern is to analyse the different values that  $\gamma$  can take.

## 4.5 The Game in Extensive Form

To make sense of all of this information and different notation, the game is drawn below in its extensive form. The reason for presenting the game this way is because it becomes much more intuitively understandable and easy to survey. In the same spirit, the game is first portrayed and described when Germany is its normal type with certainty. Second, the game when Germany is its pressured type with certainty is presented. In both of these cases, the pure strategy Nash equilibria are derived and presented. Finally, the two different scenarios is put into one, larger, game tree and the game is presented in its entirety with uncertainty with regards to the type of Germany.

### 4.5.1 The Game Tree

**The Game Tree where  $\gamma = 1$ :** See figure 2 in Appendix B. To present this part of the game, we assume that  $\gamma = 1$  and all players know this. Then Germany has

the strictly dominant strategy  $v_F^G$  and will support France no matter what. France, knowing this, will want to play  $c_M^F$  and thus a minimalistic reform package will be voted through. The UK will be indifferent to playing  $c_R^U$  or  $c_S^U$  since the payoffs will not change either way. Thus we know that France will play  $c_M^F$  with probability  $\beta = 1$  and the UK will be indifferent to playing any strategy in its mixed strategy space.

Since certainty is assumed here, we can derive two subgame perfect Nash equilibria (SPNE) using backwards induction; where the outcome is  $M$  and where the strategies  $c_M^F$ ,  $c_R^U$  or  $c_S^U$  and  $v_F^G$  is played by France, the UK and Germany, respectively. They are both marked with bold text in the game tree below.

**The Game Tree where  $\gamma = 0$ :** See Figure 3 in Appendix B. Similarly, we limit ourselves to the other part of the game tree by assuming that  $\gamma = 0$  and all players know this. Now Germany has no dominant strategy. If France plays  $c_S^F$ , then Germany will want to play  $v_F^G$  no matter what the UK does and the outcome will be  $S_F$ . If the UK campaigns for a radical reform level,  $v_R^U$ , while France is campaigning for a minimalistic reform level,  $v_M^F$ , then Germany will choose to support France and we will end up with the outcome  $M$ . However, if France plays  $v_M^F$  and the UK plays  $c_S^U$ , then Germany will support the UK and we will end up in the outcome  $S_U$ . France, knowing this ( $\gamma = 0$ ), will want to play  $c_S^F$  and thus a successive reform package,  $S_F$ , will be voted through. France will play  $c_S^F$  with probability  $1 - \beta = 1$ , and the UK will, as previously, be indifferent to playing any strategy in its mixed strategy space.

Backwards induction yields two SPNE with the outcome  $S_F$ , where the strategies  $c_S^F$ ,  $c_R^U$  or  $c_S^U$  and  $v_F^G$  is played by France, the UK and Germany, respectively. They are marked with bold text in the game tree below.

**The Game Tree where  $\gamma \in [0, 1]$ :** See Figure 4 in Appendix B. Now, France and the UK do not know the type of Germany and must make their own assessment of the probability of both  $\gamma$  and each others probabilities  $\alpha$  and  $\beta$ . The uncertainty of the UK and France with regards to where in the tree they currently are is marked with dashed lines. We can now describe the game using the theory of Bayesian games.

## 4.6 Germany

Germany is of course assumed to be full aware of which type it is in both cases. Moreover, when the UK and France have played their strategies, then Germany is assumed to be full aware of this as well before ‘casting its vote’, or playing any of its two strategies  $\{v_F^G, v_U^G\}$ . Thus Germany is considered to have full information and will always play the correct strategy to maximizing its own payoffs. It is important to note here that Germany is not choosing its type. Instead Germany is considered to be dealt a type from an external entity not part of the game’s strategic play (usually called Nature, denoted by  $N$  in the game tree).

## 4.7 The United Kingdom

The UK cannot know where in the game tree it stands when making its strategy choice: it could stand in four possible places, ‘game nodes’. Therefore, we cannot directly see what this player would do in each case as in the two descriptions with certainty above. However, we can calculate the *expected* utility of the UK,  $\pi^U$ , for playing a certain strategy,  $c_i^U, i \in \{S, R\}$  as shown below.

$$\begin{aligned}\pi^U(c_S^U) &= \gamma(\beta U_4 + (1 - \beta)U_3) + (1 - \gamma)(\beta U_2 + (1 - \beta)U_3) \\ \Leftrightarrow \pi^U(c_S^U) &= \gamma\beta U_4 + \beta U_2 - \gamma\beta U_2 + U_3 - \beta U_3\end{aligned}$$

$$\begin{aligned}\pi^U(c_R^U) &= \gamma(\beta U_4 + (1 - \beta)U_3) + (1 - \gamma)(\beta U_4 + (1 - \beta)U_3) \\ \Leftrightarrow \pi^U(c_R^U) &= \beta U_4 + U_3 - \beta U_3\end{aligned}$$

If the UK is a rational player, it will look to maximise its expected payoffs. This means that they will want to play  $c_S^U$  only when  $\pi^U(c_S^U) > \pi^U(c_R^U)$ . Plugging in the

equations for  $\pi^U(c_S^U)$  and  $\pi^U(c_R^U)$  derived above gives that

$$\begin{aligned}
& \pi^U(c_S^U) > \pi^U(c_R^U) \\
& \Leftrightarrow \gamma\beta U_4 + \beta U_2 - \gamma\beta U_2 + U_3 - \beta U_3 > \beta U_4 + U_3 - \beta U_3 \\
& \Leftrightarrow \gamma\beta + \beta U_2 - \gamma\beta U_2 - \beta U_4 > 0 \Leftrightarrow \beta((\gamma - 1)U_4 + (1 - \gamma)U_2) > 0 \\
& \Leftrightarrow \beta(1 - \gamma)(U_2 - U_4) > 0. \tag{1}
\end{aligned}$$

The interpretation of inequality (1) yields that the UK's will choose to play the strategy  $c_S^U$  for all values of  $\gamma$  and for all values of  $\beta \neq 0$ , i.e. for all values for which this strict inequality holds. This is, as shown above, equivalent to stating that the payoff for campaigning for a successive reform,  $c_S^U$ , is strictly larger than campaigning for a radical reform  $c_R^U$ . Thus the UK has a (weakly) dominant strategy,  $c_S^U$ , and will play this strategy no matter what France or Germany do. This is equivalent to set  $\alpha = 0$ , which in a Bayesian game all players are assumed to be aware of.

## 4.8 France

Analogously to the case with the UK, France will only play the strategy  $c_M^F$  if the expected payoff for playing this strategy,  $\pi^F(c_M^F)$ , is larger than the expected payoff for campaigning for a successive reform level  $\pi^F(c_S^F)$ . Recalling that the analysis of the UK gave us that  $\alpha = 0$ , we can express France's payoff function for playing strategy  $c_M^F$  to

$$\begin{aligned}
& \pi^F(c_M^F) = \gamma(\alpha F_1 + (1 - \alpha)F_1) + (1 - \gamma)(\alpha F_1 + (1 - \alpha)F_3) \\
& \Leftrightarrow \pi^F(c_M^F) = \gamma F_1 + F_3 - \gamma F_3.
\end{aligned}$$

Similarly, the payoff function for the strategy  $c_S^F$  can be written as

$$\begin{aligned}
& \pi^F(c_S^F) = \gamma(\alpha F_2 + (1 - \alpha)F_2) + (1 - \gamma)(\alpha F_2 + (1 - \alpha)F_2) \\
& \Leftrightarrow \pi^F(c_S^F) = \gamma F_2 + F_2 - \gamma F_2 \\
& \Leftrightarrow \pi^F(c_S^F) = F_2.
\end{aligned}$$

Plugging in these expressions for  $\pi^F(c_M^F)$  and  $\pi^F(c_S^F)$  and setting up an inequality showing when France would want to play  $c_M^F$  yields

$$\begin{aligned}
& \pi^F(c_M^F) > \pi^F(c_S^F) \\
& \Leftrightarrow \gamma F_1 + F_3 - \gamma F_3 > F_2 \\
& \Leftrightarrow \gamma(F_1 - F_3) > F_2 - F_3 \\
& \Leftrightarrow \gamma > \frac{F_2 - F_3}{F_1 - F_3} \equiv \bar{\gamma}. \tag{2}
\end{aligned}$$

We have now discovered an expression telling us the minimum and maximum value that  $\gamma \in [0, 1]$  may take such that France will choose to play  $c_M^F$  or  $c_S^F$ , respectively. We call this expression the limit of  $\gamma$  and denote it by  $\bar{\gamma} \in [0, 1]$ . To clarify: where the expected payoff for France of playing the strategy to campaign for a minimalistic reform level viz-á-viz playing the strategy of campaigning for a more gradual reform level, i.e.  $\pi^F(c_M^F) > \pi^F(c_S^F)$ , happens where  $\gamma > \bar{\gamma}$ . Similarly, when  $F$  will want to play  $c_S^F$  only when  $\pi^F(c_M^F) > \pi^F(c_S^F)$ , i.e. when  $\gamma < \bar{\gamma}$ . When  $\gamma = \bar{\gamma}$ , France could be considered indifferent to choosing between the two strategies.

## 4.9 Results

As we can see from the relationship  $\frac{F_2 - F_3}{F_1 - F_3}$ ,  $\bar{\gamma}$  is decreasing with  $F_3$  and  $F_1$ , while increasing in  $F_2$ . The reason  $\bar{\gamma}$  is decreasing with  $F_3$  is because  $F_1 > F_2$ .<sup>10</sup> This means that for  $\gamma < \bar{\gamma}$  to hold with certainty,  $F_2$  must be high and/or  $F_1$  or  $F_3$  must be low. Adversely, for  $\gamma > \bar{\gamma}$ ,  $F_2$  must be low and/or  $F_1$  or  $F_3$  must be high. We will look into these two cases into more detail below while only commenting briefly upon  $\gamma = \bar{\gamma}$ .

### 4.9.1 The case where $\gamma < \bar{\gamma}$

- **$F_2$  is high:** This utility describes France's payoff when the outcome  $S_F$  is realized; that is, if  $F_2$  is high, it means the utility of France when campaigning for a successive reform level is getting closer to the utility of the strategy

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<sup>10</sup>If you're still not convinced, try inputting natural numbers instead of  $F_1$ ,  $F_2$ , et cetera, and then do the division – but remember that a *lower* index should be represented by a *higher* number.

$c_M^F$  – given that Germany plays  $v_F^G$ . If, for example, France believes that the new member states will consume a larger share of the CAP budget if a minimalistic CAP reform is voted through, it may choose to show some good-will by playing  $c_S^F$  in order to get more power to specify *how* the CAP should be reformed, of course to ensure France remains a net receiver of whatever agreement is then made. However,  $F_2$  might also be high because of the, in terms of Patterson, heterogeneity of France with regards to this question. However, it does seem unlikely that rural voters are a part of the heterogeneity with regards to the CAP (even though they perhaps should be for their own best according to Messerlin (1996)). With elections looming so close it can be considered unlikely that France would prioritise these issues and risk jeopardise losing at home.

- **$F_1$  is low:** This utility describes France’s payoff when the outcome  $M$  is realized. If this is low, then it means that France values playing  $c_S^F$  higher than playing  $c_M^F$ , given that Germany will play  $v_F^G$ . This If the Doha Round is forced to close, the outcome  $M$ , even if attained, might be severely limited by level I forces acting upon the EU. Similarly, Germany and the UK, who both have incentives to make France play  $c_S^F$ , can push the Doha talks forward for exactly this reason. For the UK, it is highly feasible to push for this openly which is also shown by the fact that the British Prime Minister, David Cameron, recently announced in Davos that the Doha round ‘should finish by the end of the year’ (“Davos 2011: Doha round”, 2011). Another way to work in the same direction would be for the UK to use its relationship with the US to make the US put pressure on the EU to increase the minimum level of CAP reform politically feasible. Moreover, the new member states in the EU may absorb much of the benefit with regards to this payoff under the current system. This might lead to France choosing to play  $c_S^F$  and have power to design the reformed agreement to its benefit.

As  $F_2$  rises (or  $F_1$  falls sufficiently) we will reach the case of  $F_2 = F_1$  and shown by the limit

$$\lim_{F_2 \rightarrow F_1} \bar{\gamma} = 1,$$

at which  $c_S^F$  is the dominant strategy for France in pure strategies. It is also the case that the strategy set  $(c_S^F, c_S^U, v_F^G)$  is a Nash equilibrium. With this set of strategies and the beliefs of the UK and France regarding Germany's probability of being type  $G^p$ , maximise the expected payoffs of all players. Given that no player deviate, no other player have an incentive to do so – we have found a Bayesian Nash equilibrium. However, it is not always the case in reality that the Nash equilibria are the real outcomes because players can misjudge the intentions of other players (i.e. incorrectly assess a player's type).

- **$F_3$  is low:** Finally, the utility  $F_3$ , which represents the value of the outcome  $S_U$  for France, might also be low due to level I pressure upon the EU to be more liberal. The UK could also work to push for reform the CAP in a way such that a stronger second-pillar is emphasized, in which certain new member states get relatively (much) more than in the current situation (Zahrnt, 2009). This would ensure that, if Germany votes for the UK's proposal then France's net position might be worsened and  $F_3$  thus falls. The UK and Germany might also strongly emphasize fiscal discipline in their communication in the EU, which might make France mistake  $G^n$  for  $G^p$  and play  $c_S^F$  even though Germany is  $G^n$ . This might serve as an, perhaps not too probable, illustration for why the Nash equilibrium above might not be fulfilled in reality.

#### 4.9.2 The case where $\gamma > \bar{\gamma}$

- **$F_1$  is high:** Just as Germany and the UK can push the Doha talks, France could work to stall it. Similarly, France could endorse protectionist thinking in the EU by, for example, spreading disinformation about food security being an issue in the EU (as president Sarkozy has done on several occasions (Zahrnt, 2011a)) and thereby gain better support for realising a very minimalistic CAP reform level.
- **$F_3$  is high:** A likely way of  $F_3$  being high is when France works to create a level II shield against the effects of the outcome  $S_U$ . For example, France might make Germany commit to low level of CAP reform beforehand that

it would be embarrassing for Germany to ignore if  $S_U$  would win. Exactly this might already have happened through the Franco-German position paper (German and French Ministries of Agriculture, 2010). Another possible way of  $F_3$  being high could be that France through some means have created a level III political shield against this outcome. For example, by having struck a deal with the farm lobby at home to protest only after the French elections. This does not seem very likely, however. At the level I arena, the Mercosur talks might enable this utility to be high since the attention of the farm lobby might become split between protesting against the CAP and protesting against the Mercosur trade talks. Such protests have already been seen by one of France's supporters, Ireland.

- **$F_2$  is low:** This utility might become lower if the relative position between Germany and France changes. For example, if Germany becomes 'stronger' of the two, a slightly more reform-oriented agreement might be reached. Another reason why this might be low is that Germany sees new trading opportunities with the new member states. While engineering the CAP to fit the new member states' needs, Germany can get something else in return that increase their utilities on average. The net benefit from the CAP should then decrease for France.

Similarly to the case before, when  $F_3$  is sufficiently high,  $F_3 = F_2$  shown by the limit

$$\lim_{F_3 \rightarrow F_2} \bar{\gamma} = 0,$$

at which  $c_M^F$  is the dominant strategy for France in pure strategies. The strategy set  $(c_M^F, c_S^U, v_F^G)$  is also a Bayesian Nash equilibrium symmetrically to the case above.

#### 4.9.3 The case where $\gamma = \bar{\gamma}$

In this case, France can be seen as indifferent between the two strategies  $c_M^F$  and  $c_S^F$  which means it is not possible to know what France will choose. Two Bayes-Nash

equilibrium can be found in this case.

$$(\beta c_M^F + (1 - \beta)c_S^F, c_S^U, \bar{\gamma}v_F^G + (1 - \bar{\gamma})v_U^G), \beta \in [0, 1]$$

$$(c_S^F, \alpha c_S^U + (1 - \alpha)c_R^U, \bar{\gamma}v_F^G + (1 - \bar{\gamma})v_U^G), \alpha \in [0, 1]$$

These equilibria and the case where  $\gamma = \bar{\gamma}$  is of theoretical value and not of further interest to our analysis. There might be more Bayesian Nash equilibria to be found using mixed strategies.

## 5 Conclusions

In short, Germany wishes to raise the utility  $F_2$  in order to make the payoffs  $F_1$  and  $F_2$  more similar. If Germany is  $G^n$ , then it will want France to think that  $G = G^p$  in order to make these payoffs similar to France. There's a myriad of ways of doing this, of which a few was brought up above. The UK, similarly to Germany, wishes to raise the utility  $F_2$  or lower the utilities of  $F_1$  or  $F_3$ . With regards to the outcome of the 2013 CAP reform outcome, the following main conclusions can be drawn:

1. France's actions depend very much upon the valuation of its utility  $F_2$  relative to  $F_1$ . Some effort has been made by France, through the Franco-German position paper, to 'cushion' the effect of the case where Germany would not support France when France plays  $c_M^F$ . However, this might also have the different effect of increasing unity between the two in this question, perhaps a display for the new member states.
2. The UK will always play  $c_S^U$  in the model, which seems unlikely at the moment considering the hard liberal line campaigned. However, what is said publicly does not have to be the same as what is said in closed negotiation rooms. Thus it is very possible that the UK play this strategy realistically.
3. The new member states in the EU provide an important variable that might push the utilities of the three 'old' member states to converge. Thus we may see more coordinated action from the three, possibly indicating an outcome like the one described here as successive reform package,  $S_F$ , which will

perhaps have the aim of improving the net positions of these states on the long run.

4. Although the level I arena might impose some restrictions upon a possibly too minimalistic reform level (certainly a negative reform level will not be politically feasible), in the model there's no big probability that this would radically change anything.
5. The financial troubles of the EU, along with the focus upon fiscal discipline by Germany and the UK, might lead France to misjudge Germany's type, in which case both the UK and Germany would be better off.

All in all, the way that the UK and Germany receive their payoffs give them incentives to work for converging the utilities of all three players. There are several variables in the EU that could reasonably prompt, or catalyse, this convergence. The main conclusion of this paper is thus that the coming CAP reform alternative should contain coordinated action by the three. It could thus be seen as probable that it is the first Bayes-Nash equilibrium,  $(c_S^F, c_S^U, v_F^G)$ , that will prevail in the end.

This model is quite simple and touch upon many of the central issues in the EU's decision-making processes when it comes to reforming the CAP. However, this must be deemed to be but a fraction of the real alternatives and pressures that decision-makers face. By experimenting with Bayes-Nash equilibria in pure strategies, perhaps even more complexities could be noticed. However, it is doubtful if some more complexity would yield so much more when it comes to analysing this particular question.

The biggest difficulty with setting up this type of model is the vast span of credible choices for constructing the game and the many possibilities for creative analysis. Hopefully the way it was done and the conclusions drawn here will prove to resonate soundly with reality.

## 6 Thanks

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## A Flow-chart of the ordinary legislative procedure

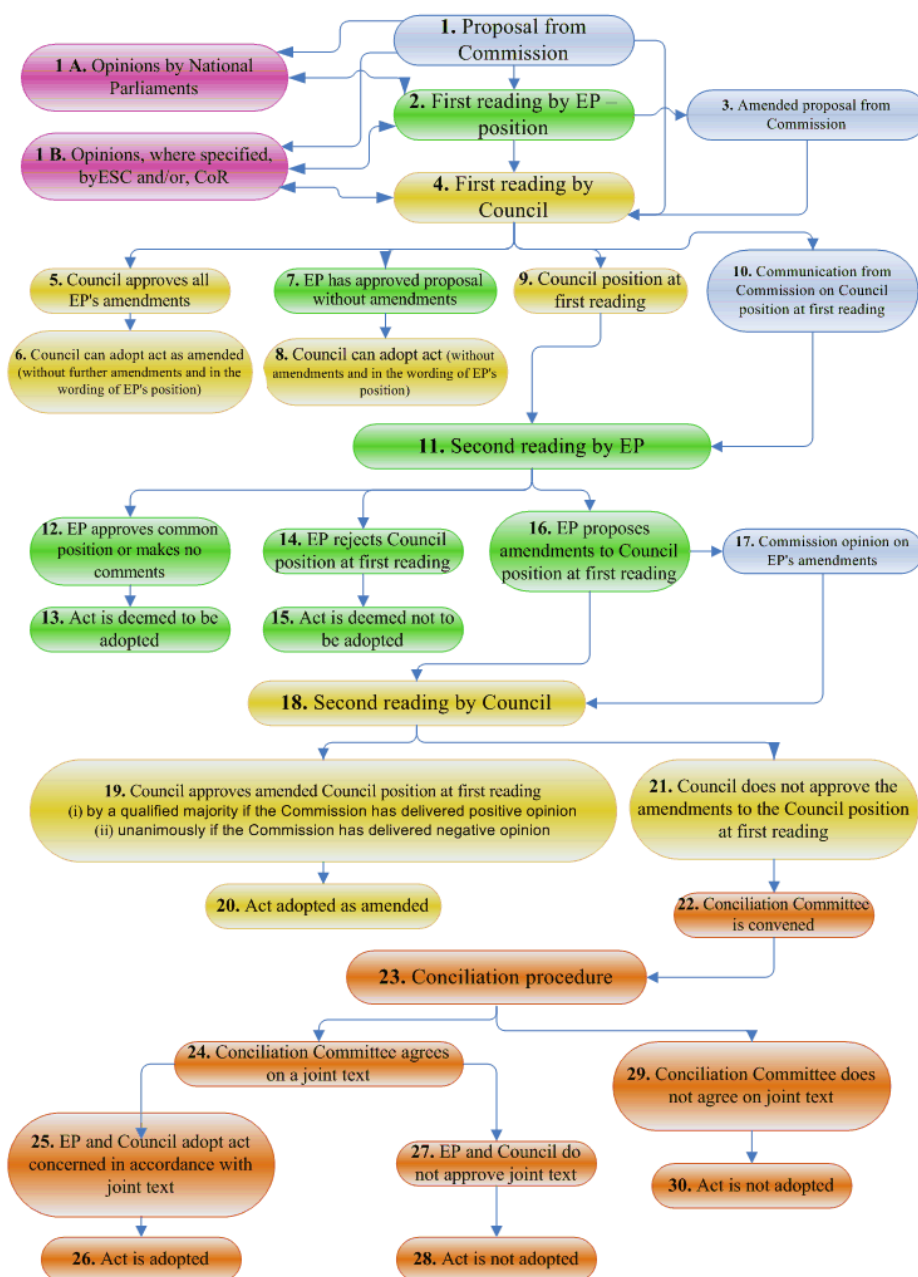


Figure 1: An illustration of the ordinary legislative procedure, or co-decision procedure, applies to changes to the common agricultural policy (CAP) since the Treaty of Lisbon. Source: <http://ec.europa.eu/codecision/>

## B The Game in Extensive Form

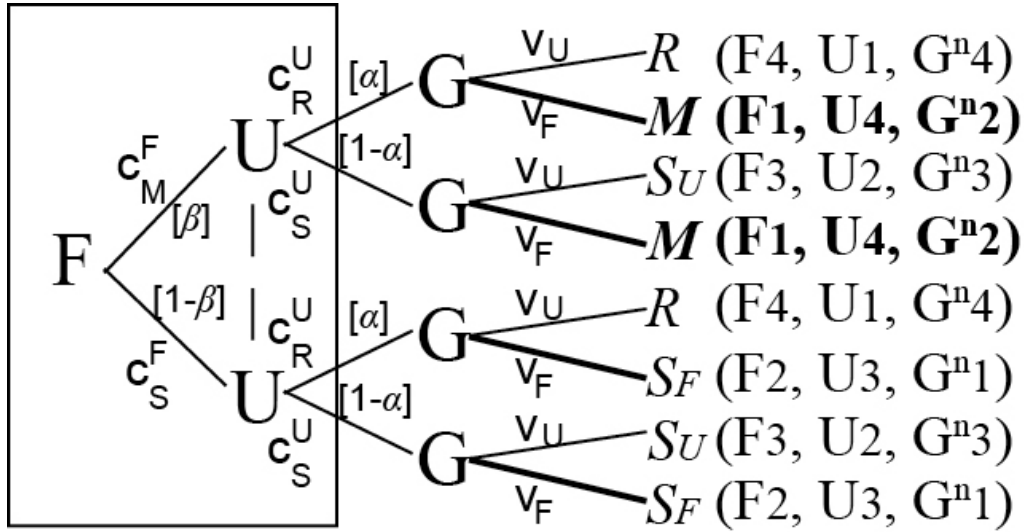


Figure 2: The Game Tree when  $\gamma = 1$  and Germany is type normal with certainty. The black box marks that France and the UK moves first, after which Germany moves. The certain, preferred move by Germany in each case is marked with a thicker line. For an explanation of the notation, see Figure 4.

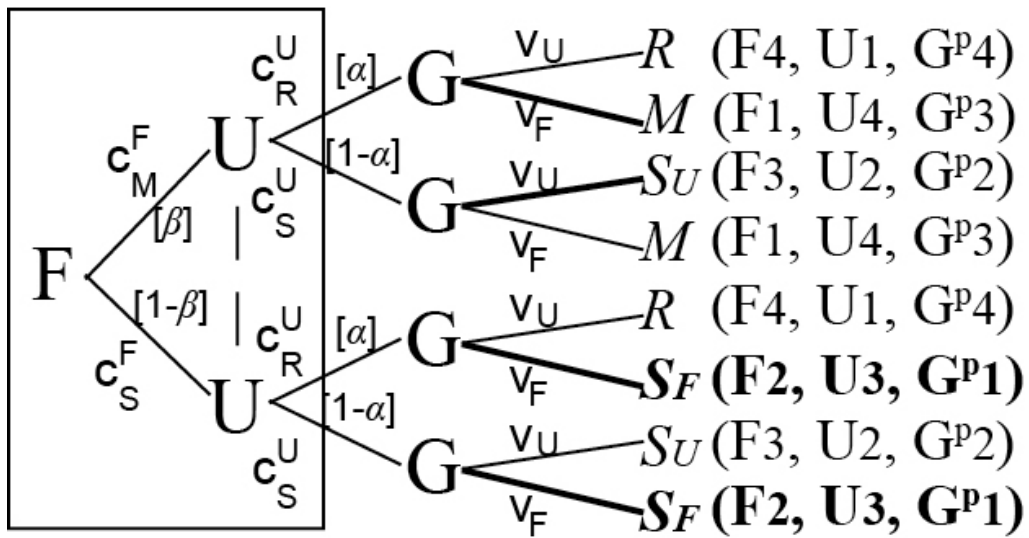


Figure 3: The Game Tree when  $\gamma = 0$  and Germany is type pressured with certainty.

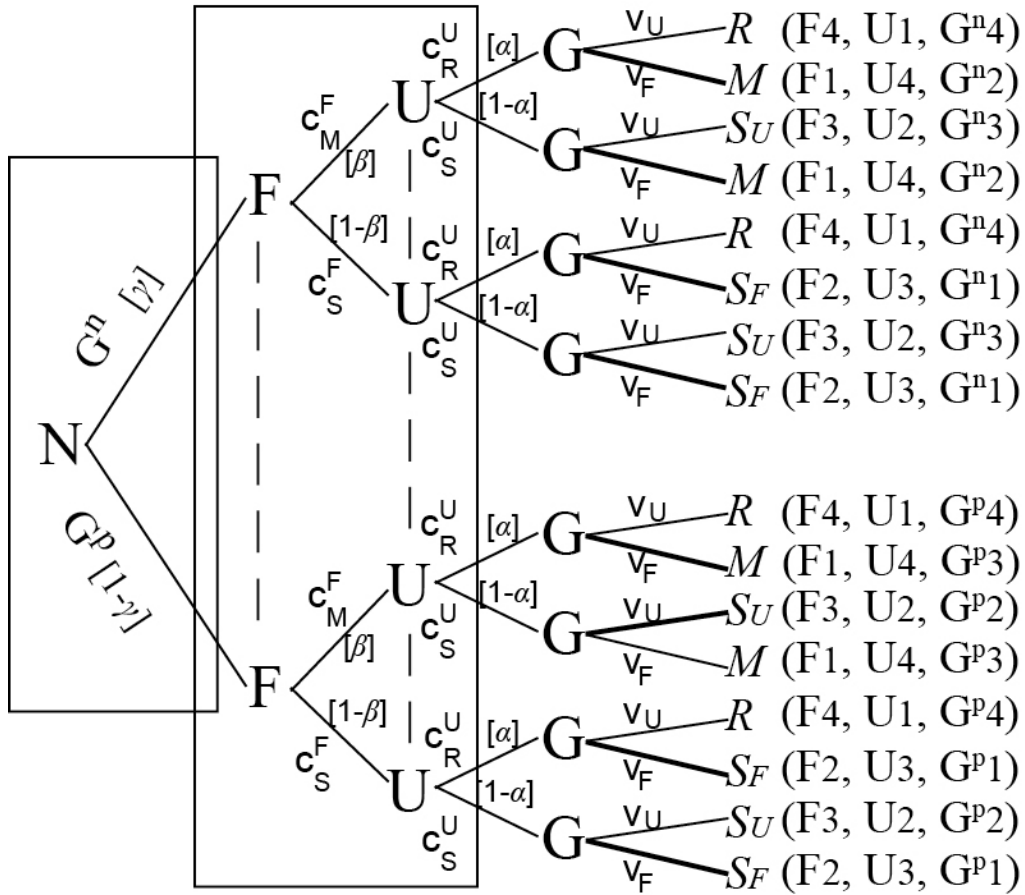


Figure 4: The Game Tree when  $\gamma \in [0, 1]$ . The first black box marks that ‘Nature’ assigns a type to Germany, the second black box marks that France and the UK moves before Germany moves. The certain, preferred move by Germany in each case is marked with a thicker line.

*Players:* F = France, U = the UK, G = Germany.

*Strategies*  $c_M^F$  = F campaigns for minimal reform,  $c_S^F$  = F campaigns for successive reform.  $c_S^U$  = U campaigns for successive reform,  $c_R^U$  = campaigns for radical reform.  $v_U$  = G votes for the UK,  $v_F$  = G votes for France. The reason for not displaying Germany’s strategies as  $v_U^G, v_F^G$  is to make the image easier to survey.

*Probabilities:*  $\beta$  = probability of France playing  $c_M^F$ ,  $\alpha$  = probability of the UK playing  $c_R^U$ .

*Reform outcomes:*  $R$  = radical,  $M$  = minimalistic,  $S_U$  = successive when the UK was supported by Germany, ( $S_F$  = successive when France was supported by Germany.

*Utilities:* The payoffs of F, U and G are such that  $F_i, U_i, G_i, i \in \{1, 2, 3, 4\}$  and a lower index denotes a higher payoff.