COMPETITION IN NONMARKET ENVIRONMENTS

Patricia Esteve González

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Author:

Patricia Esteve González

Thesis Advisors:

Dr. Matthias Dahm

Dr. Bernd Theilen

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We STATE that the present study, entitled *Competition in Nonmarket Environments*, presented by Patricia Esteve González for the degree of Doctor of Philosophy in Economics, has been carried out under our supervision at the Department of Economics of this university, and that it fulfills all the requirements to receive the European Doctorate Distinction.

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The doctoral thesis supervisor	The doctoral thesis co-supervisor
Dr. Matthias Dahm	Dr. Bernd Theilen

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Contents

Chapter 1

Introduction

This doctoral thesis analyses competitive situations in which public institutions are involved. The main characteristic of these situations is that competition is enclosed in nonmarket environments meaning that the relevant strategies can be different from those in the regular market, because they will depend on the objectives of public institutions. In other words, agents behave differently when there is a designer who chooses the parameters of the setting. This work evaluates public institutions from three different perspectives. The first contribution analyses a regular activity of public institutions: procurement of services. The second contribution regards how public institutions can change a reality: disadvantage of minorities. The third contribution studies agents perception of public institutions for the case of political parties in member countries of the European Union.

Chapter 2 considers a principal-agent relationship which can be potentially repeated, as in public procurement of services. Since effort is not contractible, there is a moral hazard problem that the principal tries to avoid by giving an advantage in the second competition to the agent who was hired in the first period and did not shirk. We analyse the linear relationship between past and current efforts through a constant elasticity of substitution function. The main result is that agent's shirking incentives decrease when the principal increases the complementarity between past and current efforts. However, the principal should not take into account the past too much because it might dampen the intensity of future competition, and even being counterproductive for the quality of services. High complementarity should be used to avoid bad practices instead of encouraging high effort. For example, the European Union has some guidelines on public procurement that suggest excluding firms from contests when they are not up-to-date with tax liabilities.

Some affirmative action policies establish that a set of disadvantaged competitors has access to an extra prize. Examples are gender quotas or a prize for national competitors in an international competition. The third chapter analyses the effects of creating an extra prize by reducing the prize in the main competition.[1] Contestants differ in ability and agents with relatively low ability belong to a disadvantaged minority. All contestants compete for the main prize, but only disadvantaged agents can win the extra prize. We show that an extra prize is a powerful tool to ensure participation of disadvantaged agents. Moreover, for intermediate levels of the disadvantage of the minority, introducing an extra prize increases total equilibrium effort compared to a standard contest. Thus, a contest designer might establish an extra prize purely on efficiency grounds. This result contrasts with the efficiency loss argument against affirmative action policies.

The last chapter examines the influence of economic factors to explain partisan support to European integration over the last three decades.[2] Policies on convergence between European Union members can be interpreted as affirmative action policies and criticisms to preferential treatment of disadvantaged countries may be also behind the increasing Euro-skepticism among governments in the European Union. We find that parties in relatively richer countries are more skeptical to European integration than parties in relatively poorer countries. On the one hand, our results show that partisan support is larger in countries with direct economic benefits from European Union membership. On the other hand, parties in countries affected by

[1] This work has been written jointly with Matthias Dahm.
[2] This work has been written jointly with Bernd Theilen.

the control of supra-national institutions are more Euro-skeptical. Moreover, we find weak evidence for larger partisan support in countries with more developed welfare states, and that support to European integration fluctuates in parallel to the business cycle. Finally, our results indicate that the importance of economic factors has grown in recent periods and that these factors are of more importance for left-wing parties in determining their support to European integration.

Since each chapter is independent of the rest, each begins with an introduction and ends with the main conclusions that are reached on the basis of its content. The appendices, relevant bibliographical references, figures and tables, if any, are added at the end of each chapter.

Chapter 2

Moral Hazard in Repeated Procurement of Services

2.1 Introduction

Contests are widely used as selection mechanisms in public procurement which represented around 20% of the GDP of OECD countries and around 14% of the GDP of non-OECD countries in 1998.[1] The US government destined 516.6 billions of dollars to public procurement contracts in 2012 and governments from the European Union countries, Norway, Iceland and Liechtenstein destined 420 billions of Euros to public procurement contracts in 2009.[2] From 2006 to 2010, 46% of these European governments' contracts were services, 68% of which were awarded by open procedures. Analysing incentives in procurement of services is relevant for many other public and private situations. The whole services sector represented 70% of

[1] Audet (2002) estimates total expenditure of government procurement.
[2] This information was obtained from US Government Spending (2013) and European Comission (2011).

world's GDP in 2010 and ranges from 74% of GDP in high income countries to 49% of GDP in low income countries.[3]

Procurement of services is characterised by a contest stage, in which an agent is selected, and a service stage, in which the agent provides the service. Since effort in services is difficult to contract, there might be incentives to shirk and, therefore, a moral hazard problem arises. This is supported by anecdotical evidence. In the provision of services, the town council of Tarragona (Spain) organizes every July the *International Fireworks Contest of Tarragona*, and the winning firm is hired to provide the fireworks of the festival of the town (in September). Some spectators think that the winner of the contest performs higher quality fireworks at the contest than at the festival. Given that the winner cannot participate in the next fireworks contest, he has incentives to shirk at the festival. We can find other situations in which effort might decrease because the incentives in the contest stage are different from the incentives in the service stage: research tournaments, labour market, elections, etc.

This chapter studies repeated procurement situations with two periods. In each period a designer organizes a contest to select one of a set of two agents and the designer hires the winner to perform a service. The fact that the game is repeated allows the designer to take into account the past to mitigate the moral hazard problem. Concretely, in the second contest, the designer gives an advantage to the first winner if he did not shirk in the past service stage. The relationship between the past effort, which is the potential advantage, and the current effort is modelled as a constant elasticity of substitution function. Results show that agents have more incentives to compete and to not shirk when the relationship between the past and the current effort is more additive (both efforts are more substitutes). When the cost of effort increases, however, the moral hazard problem is more severe and the designer should reduce the linearity but moderately; otherwise the advantage of the winner disappears jointly with the incentives to exert effort. Therefore, the designer

[3] This information was extracted from World Bank (2013).

should consider the past but not too much in the selection of the winner.

On the one hand, literature on contests considers giving an advantage to an agent as a bias in the competition, and this bias is usually either additive or multiplicative. However, this literature usually does not study the incentives of the winner after the contest. On the other hand, literature on contracts uses contests as an incentive to mitigate moral hazard problems but taking only additive advantages. This chapter contributes to both literatures by analysing a more general bias in the contest and determining the conditions under which reputational concerns arising from potential repetition of the procurement relationship can mitigate the moral hazard problem.

The rest of this chapter is organized as follows. The related literature is reviewed in the next section. The model is more formally explained in Section 2.3, and results are in Section 2.4. In Section 2.5, the model is extended in several ways and additional results are derived. Finally, concluding remarks are in Section 2.6.

2.2 Literature

The moral hazard problem has been studied extensively in contract theory in order to solve conflicts within groups or between a principal, who is the designer in our model, and an agent. When effort is not contractible, a solution is linking agent's outcome with his earnings. For example, Rogerson (1985) and Lambert (1983) consider agents' outcome in the first stage as a contract contingency in repeated principal-agent relationships.[4] However, this solution is not feasible when agents' outcome is not verifiable, as in services. An alternative solution is monitoring but it is costly and adds the problem of avoiding collusion between the supervisor and agents. Giving a bonus to an agent when he does not shirk might not be feasible because there is double-sided moral hazard, as shown by Gürtler and Kräkel (2010). When the bonus is given before the service performance, the agent has incentives to

[4] See Chiappori et al. (1994) for a survey on repeated moral hazard problems and Chiappori and Salanié (2002) for a survey on empirical support to the contract theory.

shirk. However, when the bonus is given after the service performance, the principal has incentives not to give it. Since competition incentives effort, some authors use contests to avoid moral hazard. We follow this literature and introduce reputation as a bias in contests to reduce the moral hazard problem in repeated procurement of services.[5] Notice that this chapter analyses a setting that is implemented very commonly in public and private situations: first there is a contest and, then, the winner is hired to provide a service. Our purpose is not to find an alternative mechanism to avoid moral hazard. We investigate whether a future contest induces an agent to deliver a service of high quality, and what kind of relationship between past and current effort the designer should choose.

The closest works to ours in the literature of incentives are Cesi and Albano (2008) and Meyer (1992). Cesi and Albano (2008) analyse an infinitely repeated model in public purchasing with heterogeneous agents and a sealed-bid competitive tendering. If an agent misbehaved in a service stage, the principal would add a punishment in his bid in the next selection stage as a bias. Their main result is that the optimal punishment is not too large because the hired agent may avoid to participate in the next contest.[6] We consider finite potential-repetitions of the principal-agent relationship because neither the principal nor the agents are always the same in our context. However, we obtain a similar prediction even with a finite model where agents are homogeneous and prizes are fixed. Moreover, we use the Tullock *Contest Success Function* (CSF hereinafter) with a *Constant Elasticity of Substitution Function* (CES function hereinafter) to reduce the linearity of the bias.

Meyer (1992) considers a principal who hires two agents for two periods where there is a contest in each one: an interim evaluation and a promotion. Without the interim evaluation, agents have incentives to shirk at the first period. She finds that the principal should introduce a bias additively in the promotion contest in favour of the

[5]Hölmstrom (1979) is the first work suggesting that reputation reduces the moral hazard problem.

[6]Moldovanu et al. (2012) analyses the total effort with awards and punishments and find that, under certain conditions, the optimal prize structure might be to punish the worst performer only (negative prize), to reward the best performer only (positive prize), or to both. This is an alternative incentive to a bias for internal competitions.

winner of the interim evaluation. Then, agents compete in the interim evaluation for an advantage in the promotion contest and the moral hazard problem in this first stage is solved. However, giving an advantage to the first winner decreases total effort in the promotion contest. We find the same trade-off between incentives and total effort even relaxing the assumption of an additive bias and using the Tullock contest instead of the Lazear and Rosen (1981) contest.

Beviá and Corchón (2013) consider conflict situations with two periods where the probability of winning the first contest is a bias in the probability of winning the second contest. This endogenous bias multiplies the effort in the second contest such that players compete for keeping their strengths.[7] Although these authors do not consider situations with a contest designer, there are connections between their paper and Meyer (1992). In both cases there may be a discouragement effect given by the advantage of one of the agents. When the advantage of the first winner in the second contest is very high, incentives to exert effort increase in the first period but decrease in the second contest. Our findings coincide with their ones.[8]

Notice that the literature on incentives introduces a bias in contests additively. However, in the contest literature, the bias has been studied more generally. For example, Dahm and Porteiro (2008) analyse a general function of biased efforts in the Tullock CSF for studying the effects of a lobbying competition on the correct choice of the decision-maker. They exemplify this general bias with both an additive bias and a multiplicative bias. They find that incentives behind each kind of bias are different: while the additive bias decreases the incentives to be active of the stronger agent, the multiplicative bias decreases the incentives of the weaker agent. Nevertheless, in contest literature only investments in contests are usually modelled explicitly, even when authors have an application in mind which implicitly has

[7] The multiplicative bias in the Tullock CSF was introduced by Clark and Riis (1998).

[8] Möller (2012) also find a similar trade-off considering learning effects in research contests such as the annual procurement contest organized by the US Air Force for 2000 fighter jet engines. Jofre-Bonet and Pesendorfer (2000) study empirically auctions for highway paving contracts in California and support that there are learning effect in long contracts that give advantage in future contests. In addition, they notice that past winners are regular bidders, so they might have less incentives to shirk because of reputation.

a successive principal-agent relationship.[9] Recently, Siegel (2010) introduces the notion of simple contests distinguishing investments which are conditional from those which are unconditional on winning. We show that moral hazard arises when commitment to effort conditional on winning is not feasible, as in services. We also investigate when potential repetition of the principal-agent relationship can replace this commitment.

In order to consider the past in the next period, we introduce an endogenous bias into the CSF: the effort exerted by the winner in the service stage is his bias in the next contest. We allow for a CES function that relates past effort and current effort in a contest. Then, we can connect additive bias (as in Meyer 1992 and Cesi and Albano 2008) and multiplicative bias (as in Beviá and Corch—'on 2013 and Clark and Riis 1998) by increasing complementarity between efforts. Actually, introducing complementarity means reducing the linearity of the additive bias. We find that reducing this linearity decreases the moral hazard problem. But this non-linearity (or complementarity) must be low even when effort is expensive. Otherwise, winning gives no longer an advantage, competition decreases and moral hazard is not avoided. We also extend our model and find that the moral hazard problem increases with uncertainty. This uncertainty can be captured by the number of contestants and this result is consistent with Taylor (1995) and Fullerton and McAfee (1999).

2.3 The model

Consider three players, the designer (she) and two identical agents. There are two periods ($t = 1$, $t = 2$). In each one, first the designer selects one of the agents through a contest (contest stage) and then the winning agent is hired to execute a service (service stage). Once executed the service, all players observe the winner's

[9] For example, Corchon and Dahm (2011) motivate their model with the Olympic Games although they only consider the sunk costs of the contest. However, once a city wins, this has to invest in execute its project for the Games.

effort at the service stage and the designer pays him. The prize of the contest is to be hired and the contract in each period represents revenues of 1 monetary unit. Figure 2.1 summarizes the timing of the model.

The strategies of agents are their efforts.[10] At the contest stages, agents choose simultaneously their binary efforts $e_{i,t} \in \{0,1\}$. We denote by w the winner of the previous contest stage and by l the loser. At the service stages, the winner chooses his effort $s_{w,t}$ which is also binary, $s_{w,t} \in \{0,1\}$. We assume that positive efforts are costly and the linear cost function is equal in all stages and all periods, $c_{i,t}(e_{i,t}=1) = c_{w,t}(s_{w,t}=1) = c > 0$.[11] We also assume that the cost of not exerting effort is zero. Given that the effort is not contractible, as it is not verifiable by a third person in court, the designer commits to pay the prize even when effort is zero. Hence, the hired agent has incentives to shirk.

We follow the literature by assuming a simple CSF first introduced by Tullock (1980),[12]

$$P_{i,t}(\hat{e}_{1,t},\hat{e}_{2,t}) = \begin{cases} \frac{\hat{e}_{i,t}}{\hat{e}_{i,t}+\hat{e}_{j,t}} & \text{if } \hat{e}_{i,t}+\hat{e}_{j,t} > 0 \text{ and } i \neq j \\ \frac{1}{2} & \text{if } \hat{e}_{i,t}+\hat{e}_{j,t} = 0 \text{ and } i \neq j \end{cases}, \tag{2.1}$$

where $\hat{e}_{i,t}$ is the effective effort of agent i at period t.[13] At the period 1 contest stage, this effective effort is equal to the current effort for any agent, $\hat{e}_{i,1} = e_{i,1}$. At the period 2 contest stage, agent l's effective effort is his current effort because he is not involved in the period 1 service realization. However, the designer takes into account agent w's past behaviour by considering his effort at the period 1 service

[10] Agents' effort can be interpreted as the quality of their activity. For example, Corchon and Dahm (2011) observe that the quality of Olympic Games increases with the investment of the hosting city. This example clarifies the positive relationship between quality and effort.

[11] The cost function is a positive constant c that multiplies effort in any stage. These assumptions and other aspects of the model will be generalized later.

[12] This CSF is axiomatized by Skaperdas (1996). Moreover, Corchon and Dahm (2010) give a microfundation for this CSF in which contestants are uncertain about a characteristic of the decider that is relevant for her decision. Contestants exert effort without knowing the type of the decider who decides whom to give the prize based on both the contestants efforts and her type. Then, contestants might win the contest probabilistically and the CSF is agents' perception about the type of designer and her decision. This function relates their efforts with win probabilities.

[13] Under the alternative assumption that the probability of winning is zero when no agent exerts effort, analogous results to Lemma 2.1 and Proposition 2.2 (below) hold.

stage. We define agent w's effective effort at the period 2 contest stage in equation (2.2), which is a CES function,

$$\hat{e}_{w,2} = \left(\gamma s_{w,1}^{\rho} + e_{w,2}^{\rho}\right)^{1/\rho}. \tag{2.2}$$

The weight that the designer gives to the past effort ($s_{w,1}$) is represented by γ. Past effort can be more important ($\gamma \geq 1$) or less important ($\gamma \leq 1$) than current effort ($e_{w,2}$). Notice that ρ determines the elasticity of substitution between efforts, which is equal to $1/(1-\rho)$ for the CES function (2.2). When $\rho = 1$, efforts $s_{w,1}$ and $e_{w,2}$ are perfect substitutes and the elasticity of substitution is infinite. At the other extreme, when $\rho \to -\infty$, efforts are perfect complements and the elasticity of substitution is zero. In general, when ρ decreases, the complementary between efforts increases. We focus on $\rho \in (0, 1]$ because equation (2.2) is not well defined when effort is zero and $\rho \leq 0$. Notice that efforts in equation (2.2) are additive when $\rho \to 1$ and multiplicative when $\rho \to 0$.[14]

Contestants are risk neutral and maximize their expected utility,

$$\begin{aligned} E(U_{i,1}) = P_{i,1}[1 - c_{w,1}(s_{w,1}) + \delta\left[P_{w,2}[1 - c_{w,2}(s_{w,2})] - c_{w,2}(e_{w,2})\right]] + \\ + (1 - P_{i,1})\delta\left[P_{l,2}[1 - c_{w,2}(s_{w,2})] - c_{l,2}(e_{l,2})\right] - c_{i,1}(e_{i,1}). \end{aligned} \tag{2.3}$$

At the period 1 contest stage, agent i exerts the costly effort $e_{i,1}$ and might win with probability $P_{i,1}$. In this case, he is hired at the period 1 service stage and exerts the effort $s_{w,1}$. Given this effort, he wins the period 2 contest stage with probability $P_{w,2}$. However, agent i might lose at the period 1 contest stage with probability $(1 - P_{i,1})$. In this case, he is not hired at the period 1 service stage and given $s_{w,1}$, he wins the period 2 contest stage with probability $P_{l,2}$. The winner of the period 2 contest stage will be hired at the period 2 service stage and future profits are discounted by $\delta \leq 1$.

The designer maximizes agents' efforts through the CES function and her strategy

[14]Note that $\hat{e}_{w,2} \to \gamma s_{w,1} e_{w,2}$ when $\rho \to 0$. Clark and Riis (1998) axiomatize this class of CSF.

is a pair (ρ, γ) such that she maximizes total effort in all periods. However, when having high effort in all stages is not possible, she has lexicographic preferences: she prefers high quality services (first priority) over high quality contests (secondary priority).[15] We solve the model for the representative agent i by backwards induction to find the Subgame Perfect Equilibria (hereinafter SPE) in behaviour strategies. First, we analise the model with only one period and the base model with two periods and $\rho = \gamma = 1$. Then, we let vary these variables to analyse the optimal incentives that the designer should state to maximize efforts and to avoid moral hazard.

2.4 Benchmark cases

2.4.1 Non-repeated relationship

The non-repeated relationship represents a special case of the model in Section 4.4 in which $\delta = 0$. We start solving the service stage. The winner of the contest stage shirks because his relationship with the designer ends. However, at the contest stage both agents would like to compete as long as effort is cheap. This result is formalized in Lemma 2.1 (a proof can be found in the Appendix 2.7.1).[16]

Lemma 2.1. *There is always moral hazard because the winner always shirks at the service stage. Behaviours at the contest stage depend on the cost of effort, more precisely:*

- *When the cost of effort is low, $c < 1/2$, there is a unique SPE in which both agents compete at the contest stage.*

[15] Notice that we focus on situations where efforts in both stages are useful for the designer. She may get benefits from the contest by the differentiation in services and the variety of proposals, as in research tournaments. In addition, contests may provide the principal with information, as in elections. Sometimes competition is a performance that increases welfare, as in the fireworks case. In public procurement, contests give a sign of transparency from the principal to citizens.

[16] When $c = 1/2$, agents are completely indifferent about their effort choice at the contest stage. There is, hence, multiplicity of equilibria in behaviour strategies. Focusing on symmetric behaviour strategies (since the situation is symmetric) opens the door for agents choosing any probability of entering the contest "in between" the two pure strategies described in Lemma 2.1.

- *When the cost of effort is high, $c > 1/2$, there is a unique SPE in which no agent competes at the contest stage.*

Note that apart from the functional form specified in equation (2.1), the studied situation is a special case of a Siegel (2010)'s simple contest. First, agents exert effort at the contest stage (the unconditional or sunk cost). Then, the winner has to exert effort at the service stage (the conditional cost to winning). In this sense, the winner's total cost is split.[17] Therefore, there is a moral hazard problem in the analysed contest with conditional investment.

In what follows, we analyse the conditions under which potential repetition is most effective. When the cost of effort is high ($c > 1/2$), there is not any incentive to compete at the contest stage and, thus, there is no hope to avoid moral hazard at the service stage. Therefore we focus in the sequel on $c < 1/2$.

2.4.2 Base model: a potential repeated relationship with equally weighted additive efforts

The base model considers $\delta \leq 1$, as we introduce in Section 2.3, and simplifies equation (2.2) by assuming $\rho = \gamma = 1$,

$$\hat{e}_{w,2} = s_{w,1} + e_{w,2}. \tag{2.4}$$

Equation (2.4) is a special case of a CES function in which both efforts $s_{w,1}, e_{w,2}$ are perfect substitutes ($\rho = 1$) and they have the same weight ($\gamma = 1$). We can interpret $s_{w,1}$ in equation (2.4) as an additive bias in the second contest and this yields to two different results in the first period. When effort is expensive enough, the result of Lemma 2.1 is repeated and there is moral hazard in both periods. However, when

[17] In Siegel (2010), the parameter $0 \leq \alpha \leq 1$ represents the part of the cost which is sunk or unconditional to winning and C is the total cost of the game for the winner. Then, $\alpha C = c_i(e_i)$ is the sunk cost at the contest stage and $(1 - \alpha)C = c_i(s_i)$ is the conditional cost exerted by the winner at the service stage. Given that Siegel does not allow for shirking at the service stage, our setting reduces to $c_i(s_i = 1) = c_i(e_i = 1) = c$. Equation (2.3), thus, is a special case of Siegel's setting in which $C = 2c$ and $\alpha = 1/2$.

effort is cheap enough, the winner exerts effort and then moral hazard in period 1 is avoided. Proposition 2.2 states these results formally (all calculations are in Appendix 2.7.2).

Proposition 2.2. *Both agents always exert effort in contest stages and the winner of the period 2 contest stage always shirks at the period 2 service stage. If, however, effort is relatively cheap, potential repetition can avoid moral hazard at the period 1 service stage. More precisely, we have two kinds of SPE:*

SPE I *When $c < \delta/6$, moral hazard is mitigated. Then, there is a unique SPE in which the winner of the period 1 contest stage does not shirk at the period 1 service stage.*

SPE II *When $\delta/6 < c < 1/2$, there is moral hazard. Then, there is a unique SPE in which the winner of the period 1 contest stage shirks at the period 1 service stage.*

The best situation for the designer is SPE I because she achieves two high-quality contests and a high-quality service. She can improve the results of Subsection 2.4.1 by repeating the model once and by introducing a straightforward effective effort function, equation (2.4). However, the equivalent equilibrium to the non-repeated relationship appears when the effort is expensive.

We can see that the lower the discount factor δ, the less willing agents are to exert effort and the more severe is the moral hazard problem. We could interpret a lower discount factor as a greater uncertainty about the accomplishment of the second period. In the limit ($\delta \to 0$), the situation mimics Lemma 2.1. Then, the objectives of the designer can be achieved when effort is cheap and the discount factor is high.[18]

[18]To be fully precise, when $\delta = 1$ and effort is expensive, there is another SPE in which both agents exert effort at the period 1 contest stage, the winner exerts effort at the period 1 service stage but does not at the period 2 contest stage. Meanwhile, individual l competes at the period 2 contest stage and the winner shirks at the period 2 service stage. For later reference, we denote this SPE by III. Since agent w's indifference between shirking or not at the period 1 service stage

When the cost of effort is too high and SPE I is not achievable, the moral hazard problem is not avoided by the base model. However, when we allow to vary γ and ρ, we find alternative SPE to SPE II in which the designer is better off. These alternatives are worse than SPE I because incentives not to shirk increase at the period 1 service stage, and this larger bias decreases competition at the period 2 contest stage. Nonetheless, we will see that the optimal values of γ and ρ are not far from the base model.

2.4.3 A potential repeated relationship with additive efforts

In Subsection 2.4.2 we have analysed the case where the past effort is as important as the current effort in equation (2.4). Now we relax this assumption and allow the designer to weight past effort differently to current effort while ρ remains equal to one ($\rho = 1$).[19] Consider the following effective effort,

$$\hat{e}_{w,2} = \gamma s_{w,1} + e_{w,2}, \tag{2.5}$$

where γ is a parameter specifying the relative weight of the past $s_{w,1}$. Notice that, now, the additive bias in the second contest is $\gamma s_{w,1}$ and when $\gamma = 1$, we have equation (2.4). For simplicity of the exposition, we start by assuming $\delta = 1$ although we relax this assumption later.

At the period 2 service stage, the winner of the period 2 contest stage shirks. If agent w did not exert any effort at the period 1 service stage ($s_{w,1} = 0$), his effective effort at the period 2 contest stage is his current effort. The same happens when $\gamma = 0$. In both cases, the moral hazard is repeated as in Lemma 2.1. If, however,

disappears when $\delta < 1$, we focus here on the equilibrium described in Proposition 2.2 (SPE II) and discuss SPE III in Subsection 2.4.3.

Note that there is continuity when cost of effort is $c = \delta/6$. There are multiple equilibria, in all of which both agents compete in contest stages and the winner of the period 2 contest stage shirks at the period 2 service stage. However, the winner of the period 1 contest stage is indifferent between exerting effort or not at the period 1 service stage.

[19] In the case of long contracts, as highway paving contracts in Jofre-Bonet and Pesendorfer (2000), the designer might consider past effort to be more important than current effort because of the long relationship (learning effects in their example).

agent w exerted effort at the period 1 service stage ($s_{w,1} = 1$), the effective effort at the period 2 contest stage is $\hat{e}_{w,2} = \gamma + e_{w,2}$.

As expected, results depend on how expensive the effort is (c) and on how important the past is (γ). When the past is less important than the present ($0 < \gamma \leq 1$), the results are as in Proposition 2.2. However, when the past is more important than the present ($\gamma > 1$), the moral hazard problem in the period 1 service stage is avoided for any $c < 1/2$. Proposition 2.3 states these results formally (all calculations are in the Appendix 2.7.3).

Proposition 2.3. *When $\gamma > 0$, potential repetition can avoid moral hazard at the period 1 service stage but agent w always shirks at the period 2 service stage. More precisely, we have four kinds of SPE:*

SPE I *When $c < \min\{\gamma/(2\gamma + 4), 1/((\gamma + 2)(\gamma + 1))\}$, moral hazard is mitigated. The unique SPE has both players always exert effort, but the winner of the period 2 contest stage shirks at the period 2 service stage.*

SPE II *When $\gamma \leq 1$ and $\gamma/(2\gamma+4) < c < 1/2$, there is moral hazard. The SPE has both agents exert effort in contest stages, but winners shirk in service stages.*

SPE III *When $\gamma > 1$ and $1/((\gamma + 2)(\gamma + 1)) < c < 1/(\gamma + 1)$, moral hazard is mitigated. The SPE has both agents exert effort at the period 1 contest stage, and the winner exerts effort at the period 1 service stage but not at the period 2 contest stage. Agent l exerts effort at the period 2 contest stage, and the winner shirks at the period 2 service stage.*

SPE IV *When $\gamma > 1$ and $c > 1/(\gamma+1)$, moral hazard is mitigated and the winner of the period 1 contest stage preempts his opponent. The unique SPE is both agents exert effort at the period 1 contest stage, the winner exerts effort at the period 1 service stage, but no agent exerts effort at any stage in period 2.*

For $\gamma > 1$, there are two new equilibria. As the cost of effort increases, agent w's incentives to compete in the second contest decreases (SPE III) and when cost is high enough, agent w preempts agent l (SPE IV). However, there is no moral hazard at the first service because the past is important enough. Note that Proposition 2.2 is a special case of Proposition 2.3 in which $\gamma = \delta = 1$ (see footnote 18). Figure 2.2 shows all SPE of Proposition 2.3.[20]

In order to develop an intuition, consider first the left area of Figure 2.2 in which the weight of the past is low. We see a straightforward generalization of Proposition 2.2. The lower the parameter γ, the more severe the moral hazard problem. The concave part of the solid thick line separates the areas in which the winner of the period 1 contest stage does or does not shirk at the period 1 service stage. When $\gamma = 1$, the results are the same as in Proposition 2.2.

Now, consider the right area of Figure 2.2 in which the weight of the past is high from region I and $\gamma = 1$. When parameter γ and the cost increase, exerting effort at the period 2 contest stage is less worth although moral hazard is avoided at period 1. In region III, agent w stops effort in the period 2 contest stage because he can use the advantage from not shirking in the period 1 service stage instead of expensive effort. The convex part of the solid thick line separates the areas in which the winner of the period 1 contest stage does or does not compete at the period 2 contest stage. In region IV, agent w's advantage and the cost of effort are even so high that agent l is completely discouraged from competing at the period 2 contest stage. The striped thick line separates the areas where the loser of the period 1 contest stage competes or not at the period 2 contest stage.

The designer has the following preference relationship over the SPE: $SPEI \succ SPEIII \succ SPEIV \succ SPEII$. The value of the cost which players are willing to pay in SPE I is maximized when $\gamma = 1$, which yields the base case of Proposition 2.2. If the effort is expensive enough, SPE I is not reachable. Then, the designer can avoid moral hazard by increasing a little the weight of the past ($\gamma > 1$) at expense of decreasing competition at the period 2 contest stage. However, this is possible as long as the discount factor is high enough. We can see the impact of the

[20]The name of regions in Figure 2.2 corresponds to the name of SPE in Proposition 2.3.

discount factor on Proposition 2.3 in Figure 2.3.

When the discount factor decreases $\delta < 1$, the value for gamma that maximizes the value of the cost which players are willing to pay in SPE I increases to compensate the uncertainty effect. The solid thick line is lower because effort is cheaper in period 2 and agent w is less willing to exert effort at the period 1 service stage. The SPE II, which has moral hazard at period 1, narrows the space of SPE III and IV and at the limit, when $\delta \to 0$, there is only the SPE II and the situation mimics Lemma 2.1. Overall these results show the robustness of the base model results: the designer maximizes efforts stating γ close to one.

2.4.4 A potential repeated relationship with equally weighted efforts

In order to introduce some degree of complementarity, now we allow the designer to reduce the linearity of equation 2.4 while efforts remain with the same weight $\gamma = 1$,

$$\hat{e}_{w,2} = (s_{w,1}^{\rho} + e_{w,2}^{\rho})^{\frac{1}{\rho}}, \tag{2.6}$$

where parameter ρ determines the elasticity of substitution. This generalization allows us to increase the complementarity between efforts and to introduce non linearity between the bias $s_{w,1}$ and the current effort $e_{w,2}$ when ρ decreases. Notice that when $\rho \to 0$, agent w's probability of winning the period 2 contest stage is almost 1 if he exerts effort in both the period 1 service stage and the period 2 contest stage.[21] This causes a severe disincentive effect on agent l. For simplicity of the exposition, we start by assuming $\delta = 1$ but relax this assumption later.

At the period 2 service stage, the winner of the period 2 contest stage shirks. If agent w did not exert effort at the period 1 service stage, his effective effort at the period 2 contest stage is his current effort and the situation mimics Lemma 2.1.

[21] The cause of this implication is that $s_{w,1}^{\rho} + e_{w,2}^{\rho} > 1$ when $s_{w,1} = e_{w,2} = 1$. Given that the effective effort $(s_{w,1}^{\rho} + e_{w,2}^{\rho})^{\frac{1}{\rho}}$ is convex for $\rho \in (0, 1]$, this effective effort increases when ρ decreases. There are opposite implications when $s_{w,1}^{\rho} + e_{w,2}^{\rho} < 1$.

However, if he exerted effort at the period 1 service stage, the effective effort at the period 2 contest stage is $\hat{e}_{w,2} = (1 + e_{w,2}^{\rho})^{\frac{1}{\rho}}$. Moral hazard is avoided at the period 2 service stage when effort is cheap enough and/or complementarity is high enough. Proposition 2.4 states these results formally (all calculations are in the Appendix 2.7.4).[22]

Proposition 2.4. *If effort is cheap, potential repetition can avoid moral hazard at the period 1 service stage. Both agents exert effort at the period 1 contest stage but agent w always shirks at the period 2 service stage. More precisely, we obtain the following SPE:*

SPE I *When* $c < \min\{1/(2^{1/\rho}+1), (2^{1/\rho}-1)/(2(2^{1/\rho}+1))\}$*, moral hazard is mitigated. The unique SPE has both agents exert effort always, but at the period 2 service stage.*

SPE II *When* $(2^{1/\rho}-1)/(2(2^{1/\rho}+1)) < c < 1/2$*, there is moral hazard. The SPE in behaviour strategies has both players exert effort at the contest stages, and the winners shirk at the service stages.*

SPE V *When* $1/(2^{1/\rho}+1) < c < (2^{1/\rho}-1)/(2(2^{1/\rho}+1))$*, moral hazard is mitigated. The SPE in behaviour strategies has agent w exerts effort at the period 1 service stage. At the period 2 contest stage, he exerts effort with probability* $r_{w,2} = (2^{1/\rho}+1)/(2^{1/\rho}-1) - 2c(2^{1/\rho}+1)/(2^{1/\rho}-1)$ *and agent l exerts effort with probability* $q_{l,2} = 2c(2^{1/\rho}+1)/(2^{1/\rho}-1)$.[23]

Proposition 2.2 is a special case of Proposition 2.4 in which $\rho = \delta = 1$. All SPE of Proposition 2.4 are represented in Figure 2.4. Consider first the right of Figure 2.4 in which the efforts $s_{w,1}$ and $e_{w,2}$ are better substitutes ($\rho \to 1$). The lower the parameter ρ, the less severe the moral hazard problem. Note that the value of the

[22] When $\delta = 1$ and the cost of effort is $(2^{1/\rho}-1)/(2(2^{1/\rho}+1)) < c < 1/2$, agent w is indifferent at the period 1 service stage and there are two SPE. But when $\delta < 1$, as in the base model, this indifference disappears and there is only the SPE II (see footnote 18).

[23] Note that $1/(2^{1/\rho}+1) < (2^{1/\rho}-1)/(2(2^{1/\rho}+1))$ only when $0 < \rho < ln(2)/ln(3)$.

cost that players are willing to pay in SPE I is maximized when $\rho = ln(2)/ln(3)$.[24] Therefore, results of the base model are strengthened because it becomes easier to induce a service of high quality. The solid thick line separates the areas where the winner of the period 1 contest stage shirks or not at the period 1 service stage.

Now, consider the left of Figure 2.4 in which the efforts are more complementary from region I and $\rho = ln2/ln3$. By decreasing the parameter ρ, the moral hazard problem is less important and exerting effort at the period 2 contest stage is less worth. The striped thick line separates the areas where agents exert effort at the period 2 contest stage and where they are indifferent. When this line is below the solid thick line, there is an area between them in which there is the new SPE V.

In SPE V, moral hazard in period 1 is avoided and agents play behaviour strategies at the period 2 contest stage. When $c = 1/4$, both agents have the same probability of competing. If the cost of effort increases, agent w decreases his probability of competing because of his advantage from not shirking, and then agent l has more incentives to compete. If, however, the cost of effort decreases, agent w has more incentives to compete, but then agent l has less incentives. These behaviours are consistent with the other SPE.[25]

The designer has the following preference relationship over the SPE: $SPEI \succ SPEV \succ SPEII$. If effort is expensive enough, SPE I is not reachable. However, the designer might get SPE V if she increases complementarities ($\rho < ln2/ln3$) at expense of decreasing competition at the period 2 contest stage. This is possible as long as the discount factor is high enough. Figure 2.5 shows that the lower the discount factor, the higher agent w's incentives to shirk at the period 1 service stage. Then, both lines moves down and, at the limit ($\delta \to 0$), the situation mimics Lemma 2.1.

In this section we see that an introduction of complementarity helps the designer

[24] In SPE I, players are willing to pay a higher cost ($c < 1/4$) than in the base model ($c < 1/6$).
[25] When $c = 1/(2^{1/\rho} + 1)$, $(r_{w,2}, q_{l,2}) = (1, 2/(2^{1/\rho} - 1))$ and when $c = (2^{1/\rho} - 1)/2(2^{1/\rho} + 1)$, $(r_{w,2}, q_{l,2}) = (2/(2^{1/\rho} - 1), 1)$.

to maximize efforts. Agents are even more willing to pay for effort in SPE I with $ln2/ln3 < \rho < 1$ than in the base model with $\rho = 1$. Therefore, when effort is cheap, the designer should introduce some complementarity between efforts. When effort is expensive enough and SPE I is not feasible, the designer should increase complementarity to achieve at least SPE V but not too much. When we analyse the limit case $\rho \to 0$ with an effective effort as with a Cobb-Douglas production function,

$$\hat{e}_{w,2} = s_{w,1} e_{w,2}, \tag{2.7}$$

we see that the bias stops being an advantage. SPE I is achievable for cheap effort again, but the effect is counterproductive for expensive effort where there is moral hazard in both periods. Proposition 2.5 states the results in this new case (all calculations are in the Appendix 2.7.5).

Proposition 2.5. *Only if effort is cheap, potential repetition can avoid moral hazard at the period 1 service stage. More precisely, the SPE are:*

SPE I *When $c < 1/4$, moral hazard is mitigated. The unique SPE has both agents exert effort always, but at the period 2 service stage.*

SPE VI *When $1/4 < c < 1/2$, there is moral hazard. Both agents compete in the period 1 contest stage, but only agent l competes at the period 2 contest stage. Winners do not exert effort at service stages.*

Given that agent w chooses $s_{w,1} = e_{w,2}$ in equilibrium at the period 2 contest stage, equation (2.7) can be interpreted as efforts $s_{w,1}$ and $e_{w,2}$ are perfect complements. Now the bias is a punishment instead of an advantage. If agent w performed a good service in period 1, he would have no advantage in the next contest. And if he shirked, he has an effective effort equal to zero even if his effort is high at the period 2 contest stage.[26] When effort is cheap enough, agent w tries to compete against

[26] We can see this kind of rules in public service contracts of European Union member countries. The governments of those countries exclude firms who have not paid social security contributions or taxes. Another example is a direct red card in a football match that may disqualify a player for several matches.

agent l for the second service.[27] However, results with perfect complementarity do not increase the cost that agents are willing to pay for SPE I in Proposition 2.4.

When c is high enough, agents have no incentives to compete in period 1 because exerting effort twice is too expensive. Given that agent w cannot use the bias $s_{w,1}$ as an advantage, incentives to exert effort at the period 1 service stage disappear and moral hazard is not avoided. Agent l has incentives to compete at the period 2 contest stage because by increasing effort he goes from a probability of winning 1/2 to 1. The designer has the following preference relationship over the SPE: $SPEI \succ SPEVI$.

The discontinuity between Propositions 2.4 and 2.5 is due to the assumption of binary effort with values zero and one. Reducing the linearity of the additive bias avoids moral hazard as long as the complementarity between efforts is low enough. Therefore, results of the base model, where the bias is additive and efforts perfect substitutes, are quite robust and straightforward to implement.

We have seen in this section that the designer can reduce the moral hazard problem, with the setting described in Section 2.3, by choosing γ and ρ. Increasing the weight of the past, γ, reduces the incentives to shirk in the period 1 service stage. By fixing $\rho = 1$, however, we observe that the higher the weight of the past, the higher the trade-off between the incentives not to shirk in the first service and the incentives to compete in the second contest. Also, the maximum cost that agents are willing to pay for exerting effort always but in the last service, the desired SPE I, is achieved when $\gamma = 1$. The level of linearity between the past and the present, determined by ρ, changes their relationship going from perfect complements to perfect substitutes. From both extremes, moving to an intermediate situation, in which the linearity of equation 2.4 is reduced, increases the willingness of agents to exert effort in SPE I. However, increasing complementarities not only increases the trade-off between not shirking and competition, but also reduces the advantage of being a winner. That

[27] This result coincides with Beviá and Corchón (2013) because agent w fights for keep his strength in the second contest.

means, in our model, that an additive bias is a better incentive than a multiplicative bias. Corollary 2.6 sums up the obtained results in Section 2.4,

Corollary 2.6. *The moral hazard problem is less severe when the designer states an additive bias determined by $\gamma = \rho = 1$ in equation 2.2, that is when she considers the past but not too much.*

2.5 Extensions

In this section we focus on additive efforts ($\rho = 1$) and generalize some assumptions of the model in Section 2.3. We consider a larger pool of potential providers and continuous efforts with a generalization of Tullock's CSF. Then we turn to the all-pay auction CSF and finally we relax the assumption that the cost of effort in both contest stage and service stage are equal.

2.5.1 Continuous efforts and a generalized CSF

There are many situations in which agents choose continuous effort instead of binary effort (some examples are in Beviá and Corchón 2012; Che and Gale 2003; Epstein et al. 2011). In this section we allow for continuous efforts $e_{i,t}, s_{w,t} \in \Re_+$ and thereby extend the case analysed in Section 2.4.3. Moreover, we generalize the CSF to exponents different from one,

$$P_{i,t}(\hat{e}_{i,t}, \hat{e}_{j,t}) = \begin{cases} \frac{\hat{e}^r_{i,t}}{\hat{e}^r_{i,t}+\hat{e}^r_{j,t}} & \text{if } \hat{e}^r_{i,t} + \hat{e}^r_{j,t} > 0 \\ \frac{1}{2} & \text{otherwise} \end{cases}, \tag{2.8}$$

where the exponent satisfies $r \in (0, 2]$.[28] This parameter allows to vary the degree of noise in the selection process and can be interpreted as different amounts of

[28] At period 2 contest stage, when we consider the second order condition of agent l's expected utility, we have the usual condition of concavity $r < 2$. However, agent w's condition of concavity is $r < 2 + 4c\gamma s_{w,1}$. Note that $2 \leq 2 + 4c\gamma s_{w,1}$, therefore the level of noise must be $r < 2$ as usual and then both agents maximize their expected utilities. See Pérez-Castrillo and Verdier (1992).

waste in the selection process. We use as effective effort equation (2.5) instead of equation (2.4) because with the last, moral hazard is not avoided. We solve the model assuming $\delta \leq 1$.

At the period 2 service stage, agent w shirks, and at the period 2 contest stage both agents exert the same effective effort $e_{l,2} = \hat{e}_{w,2} = r/4c$.[29] This interior solution implies that the higher the incentives to avoid moral hazard at the period 1 service stage, the less agent w competes at the period 2 contest stage. We find that moral hazard can be avoided if the past is important enough and this depends not only on the discount factor δ but also on the weight of the past γ. More formally (all calculations are in the Appendix 2.7.6),

Proposition 2.7. *If efforts are continuous, potential repetition and a sufficiently high weight on the past can avoid moral hazard at the period 1 service stage, but agent w always shirks at the period 2 service stage. More precisely:*

- *When $\delta\gamma \leq 1$, there is moral hazard. The SPE has both players exert effort $e_{i,t} = r/4c$ at contest stages, and the winners shirk $s_{w,t} = 0$ at the service stages.*[30]

- *When $\delta\gamma \geq 1$, moral hazard is mitigated. The SPE has both players exert the same effort at the period 1 contest stage $e_{i,1} = (r/4c)[1 + (\delta r/4) - (r/4\gamma)]$, and the winner exerts the effort $s_{w,1} = r/(4c\gamma)$ at the period 1 service stage. However, this agent does not compete at the period 2 contest stage while his opponent does $e_{l,2} = r/4c$.*

Notice that when the past is not important ($\delta\gamma \leq 1$), moral hazard is not avoided at the period 1 service stage. This result is analogous to the SPE II in the discrete game. Efforts at contest stages are the lower the higher the cost of effort, as in the base model, and the lower r is. The reason behind this is that a very high noise

[29] The fact that $e_{l,2} = \hat{e}_{w,2}$ comes from the addition of effective effort. See Dahm and Porteiro (2008) for a related result in a different context and other function forms.

[30] Note that the equilibrium efforts when the past is not important ($\delta\gamma \leq 1$) coincide with the well known result of the Tullock contest with homogeneous contestants.

is analogous to ignoring the past: the probability of winning the period 2 contest stage is one half regardless the effort in the period 1 service stage.[31]

When the past is important enough ($\delta\gamma \geq 1$), results are very similar to SPE III and SPE VI in the discrete game. Agent w prefers not to shirk at the period 1 service stage but not to compete at the period 2 contest stage because costs are lower $((r/4)[1+(\delta r/4)-(r/4\gamma)]+(r/4\gamma)+0)$ than when he shirks but competes at the period 2 contest stage $((r/4)+0+(\delta r/4))$. On the other hand, agent l competes more at the period 1 contest stage than at the period 2 contest stage.[32] When the cost increases, his effort at the period 2 contest stage decreases and we go from SPE III to SPE IV in the discrete game.[33]

These results are analogous to Proposition 2.3 although SPE I, in which all agents exert effort always but in the last service stage, is only approached when $\delta\gamma = 1$. Then, agent w is indifferent between shirking or not at the period 1 service stage. This agent may exert effort at both the period 1 service stage and the period 2 contest stage, but the sum of both efforts will be never larger than $r/4c$.

Given these results, the designer should choose a sufficiently high weight of the past to avoid moral hazard ($\delta\gamma \geq 1$). However, the higher γ is, the lower the effort at the period 1 service stage. Thus, the designer should choose $\gamma = 1/\delta$ and she should consider that efforts increase with r and δ. Taking all this together, the results of the continuous model are not so different from the discrete base model.

[31] This SPE is unique because when we consider that both agents does not compete at the period 2 contest stage, both players have incentives to exert a low effort to win without a high cost.

[32] Actually, both agents exert more effort at the period 1 contest stage than at the period 2 contest stage when $\delta\gamma \geq 1$. The reason is that agents value the period 1 service stage more because it allows to compete in the second period at a lower cost.

[33] This SPE is unique because when we consider that both agents does not compete at the period 2 contest stage, agent l has incentives to compete. The reason behind this is that agent w did not shirk at the period 1 service stage and this advantage is high enough to not compete at the second contest. This result is consistent with Pérez-Castrillo and Verdier (1992) who find that a low noise allows the advantageous agent to preempt his opponent.

2.5.2 All Pay Auction CSF

In addition to the Tullock CSF, the All Pay Auction is another CSF which is used commonly in the contest literature (see Konrad 2009; Siegel 2010; Corchón and Dahm 2011; Epstein et al. 2011). In this section we analyse the base model when the CSF is the all-pay auction,

$$P_{i,t}(\hat{e}_{i,t}, \hat{e}_{j,t}) = \begin{cases} 1 & \text{if } \hat{e}_{i,t} > \hat{e}_{j,t} \text{ and } i \neq j \\ 1/2 & \text{if } \hat{e}_{i,t} = \hat{e}_{j,t} \text{ and } i \neq j \\ 0 & \text{if } \hat{e}_{j,t} > \hat{e}_{i,t} \text{ and } i \neq j \end{cases}, \tag{2.9}$$

where the effective effort is given by equation (2.4).[34] Again, we assume that efforts are binary. When cost of effort is low enough, moral hazard is avoided. Then, we find a similar SPE to SPE V of Section 2.4.4 but with lower probabilities of competing at the period 2 contest stage. More formally (all calculations are in the Appendix 2.7.7),

Proposition 2.8. *Both agents always compete at the period 1 contest stage but agent w always shirks at the period 2 service stage. However, if effort is cheap enough, potential repetition can avoid moral hazard at period 1 service stage. More precisely, we obtain two SPE:*

SPE VII *When $c < \delta/2$, moral hazard is mitigated. The SPE has agent w does not shirk at the period 1 service stage, and both agents exert effort with probabilities $(r_{w,2}, q_{l,2}) = (1 - 2c, 2c)$ at the period 2 contest stage.*

SPE II *When $\delta/2 < c < 1/2$, there is moral hazard. The SPE has players compete at the contest stages and the winners shirk at the service stages.*

Although moral hazard can be avoided when $c < \delta/2$, competition at the period 2 contest stage decreases. In SPE VII both players have the same probability of competing at the period 2 contest stage when $c = 1/4$. When the cost increases,

[34] In this case we assume that there is no noise at the contest stages.

the incentives to compete of agent l also increase. Meanwhile, the incentives to compete of agent w decrease, as a result of his advantage of not shirking at the period 1 service stage. When the cost of effort decreases, the direction of these incentives are opposite and agent l has less incentives to compete.[35] As in the base model, the lower the discount factor, the more severe the moral hazard problem. However, when we use all-pay auctions, this problem is less serious because the maximum cost that agents are willing to pay in SPE VII is larger than in the SPE I of the base model.[36] Notice that Proposition 2.8 does not have SPE I in pure strategies. The trade-off between not shirking in the period 1 service stage and competing in the period 2 contest stage is stronger with an all-pay auction. On the one hand, the designer should consider an all-pay auction because the moral hazard problem is avoided. On the other hand, SPE I is not achievable in this case while it is in the case considered in Section 2.4.2.

2.5.3 Large pool of providers

We can find many examples of contests with more than one agent such as the public procurement negotiated procedures in the European Union where the public agencies must invite to at least three candidates. In this section we extend the base model to n agents where n is any positive natural number equal or higher than 2. We generalize the CSF to

$$P_{i,t}(\hat{e}_{1,t}, \hat{e}_{2,t}, \ldots, \hat{e}_{i,t}, \ldots, \hat{e}_{n,t}) = \begin{cases} \frac{\hat{e}_{i,t}}{\sum_{j=1}^{N} \hat{e}_{j,t}} & \text{if } \sum_{j=1}^{N} \hat{e}_{j,t} > 0 \\ \frac{1}{N} & \text{otherwise} \end{cases}, \tag{2.10}$$

where the effective effort is given by equation (2.4). In this section we assume $\delta \leq 1$ and $c < 1/N$.[37] Given the symmetry of the situation, we focus on equilibria in which the losers of the period 1 contest stage choose the same action at the period

[35] This situation is very similar to the SPE V of Proposition 2.4 despite the fact that now $\rho = 1$ and the CSF is deterministic.

[36] This additional result is also present in the previous section: the larger the noise ($r \to 0$), the more severe the moral hazard problem.

[37] When $c > 1/N$, agents do not exert effort either at the contest stages or at the service stages.

2 contest stage.

We find that the moral hazard problem can be avoided when there are more than two competitors. Nevertheless, this problem is more severe the lower discount factor δ is and the larger number of competitors N there are. More formally (all calculations are in the Appendix 2.7.8),

Proposition 2.9. *All agents always exert effort in contest stages and the winner of the period 2 contest stage always shirks at the period 2 service stage. If, however, effort is cheap, potential repetition can avoid moral hazard at the period 1 service stage. More precisely, we obtain the following SPE:*

SPE I *When $c < \delta(N-1)/(N^2+N)$, moral hazard is mitigated. The SPE has all agents exert effort always but agent w at the period 2 service stage.*

SPE II *When $\delta(N-1)/(N^2+N) < c < 1/N$, there is moral hazard. The SPE has agents compete at contest stages but the winners shirk at the period 1 service stage.*

Proposition 2.2 is a special case of Proposition 2.9 in which $N = 2$.[38] Increasing the number of agents has two effects: competition at the contest stages is decreased, and the interval in SPE II is increased at the expense of the interval in SPE I. In other words, the larger the pool of providers, the lower the probability of winning, and the more severe the moral hazard problem. This conclusion is consistent with Che and Gale (2003) and Fullerton and McAfee (1999) when contestants are heterogeneous. Consequently, the designer should consider the lowest number of competitors possible.

2.5.4 The cost of the effort depends on the stage

Our model applies to situations in which the tasks in services are different from the tasks in contests, resulting in different costs. Now we consider that the cost of

[38] Note that agent w is indifferent between shirking or not at the period 1 service stage when $c = \delta(N-1)/(N^2+N)$.

exerting effort at the contest stages can be different from the cost at the service stages in the base model of Subsection 2.4.2. Then, the linear cost function in services is $c_s(s_{w,t}) = c_s s_{w,t}$ and in contests is $c_c(e_{i,t}) = c_c e_{i,t}$. Results depend on which stage the effort is more expensive.

Consider that the effort at service stages is the most expensive $c_s \geq c_c$. The results, which are analogous to Proposition 2.2, are explained formally in Proposition 2.10.

Proposition 2.10. *Let $c_s \geq c_c$ or both $c_s \leq c_c$ and $0 < \delta c_c < \delta/6$. Both agents always exert effort in contest stages, and the winner of the period 2 contest stage always shirks at the period 2 service stage. If, however, the effort in services stages is cheap, potential repetition can avoid moral hazard at the period 1 service stage. More precisely, we have the following SPE:*

SPE I *When $c_s < \delta/6$, moral hazard is mitigated. The unique SPE has the winner of the period 1 contest stage does not shirk at the period 1 service stage.*

SPE II *When $\delta/6 < c_s < 1/2$, there is moral hazard. The unique SPE has the winner of the period 1 contest stage shirks at the period at the period 1 service stage.*

Consider now that the effort at contest stages is the most expensive $c_c \geq c_s$. In this case, results depend on both types of cost. When $0 < \delta c_c < \delta/6$, results are the same as in Proposition 2.10. However, when $\delta/6 < \delta c_c < 1/2$, there is the SPE III in addition to the SPE I and II because agent w has less incentives to shirk at the period 1 service stage. Agent w substitutes his future effort with his current effort when this is lower than the discounted future effort. These results are explained formally in Proposition 2.11 and they are similar to Proposition 2.3 but for $\gamma = \delta = 1$.

Proposition 2.11. *Let both $c_c \geq c_s$ and $\delta/6 < \delta c_c < \delta 1/2$. Agents exert effort at the period 1 contest stage, and agent w always shirks at the period 2 service stage. If,* *however, the effort in services stages is cheap, potential repetition can avoid moral hazard at the period 1 service stage. More precisely, we have these three SPE:*

SPE I *When $c_s < \delta/6$, moral hazard is mitigated. The unique SPE has agent w does not shirk at the period 1 service stage and both agents exert effort at the period 2 contest stage.*

SPE II *When $\delta/6 < \delta c_c < c_s < 1/2$, there is moral hazard. The SPE has agent w shirks at the period 1 service stage and both agents exert effort at the period 2 contest stage.*

SPE III *When $\delta/6 < c_s < \delta c_c < 1/2$, moral hazard is mitigated. The SPE has agent w does not exert effort either at the period 1 service stage or at the period 2 contest stage. Meanwhile, agent l exerts effort at the period 2 contest stage.*

In Propositions 2.10 and 2.11, SPE I is achieved when the cost of effort is low enough (all calculations are in the Appendix 2.7.9). This problem is less severe, of course, when the cost of contest stages is higher than the cost of service stages. In this case, when SPE I is not reachable, the designer might get SPE III if the discounted cost of contest stages is still higher than the cost of service stages.[39] Then the moral hazard problem is solved to the detriment of competition at the period 2 contest stage. However, the lower the discount factor, the more severe the moral hazard. All these conclusions support the results of the base model and its extensions.

2.6 Conclusions

We analyse incentives of biasing a contest to avoid moral hazard in repeated procurement of services. We build a base model as a Siegel's simple contest and our contribution is to consider a general bias with a CES function in an endogenous

[39]As in Section 2.4.3, the designer's preferences on the SPE are $SPEI \succ SPEIII \succ SPEII$.

model. We find that the moral hazard problem is mitigated by reducing the addition of the bias. However, if the bias has a multiplicative form, the winner has no advantage in the future and this kind of bias may be counterproductive.

Therefore, the designer should consider both the effort in the first service stage and the effort in the second contest stage as substitutes and with the same importance. As a result of this base model, the designer is able to induce a service of high quality in period 1, and contests of high quality in both periods when effort is cheap and future is certain. If effort is more expensive, she should increase the importance of the past or introduce some complementarity between efforts. However, there is a trade-off between the incentives to avoid moral hazard in the period 1 service stage and the competition in the period 2 contest stage. Moreover, when complementarity is too high, there is no advantage of not shirking in the first service, moral hazard is not mitigated and competition in the second contest stage is reduced.

The results of the base model are robust when we vary some assumptions. The trade-off between incentives and competition is more severe when we consider continuous efforts with a more general Tullock's CSF and when we take all-pay auctions. Uncertainty increases the moral hazard problem not only with the discount factor, but also with a higher pool of contestants (the probability of winning decreases) and with noise (contestants does know the determinants for winning). The effect of uncertainty stresses the importance of the designer's commitment to apply the repeated biased contest. Finally, the winner has less incentives to shirk when the cost at the service stages is lower than the cost at the contest stages.

As we said above, additive bias (meaning substitute efforts) gives the right incentives in moral hazard problems although reducing the linearity (meaning increasing the complementarity) improves incentives to avoid moral hazard. However, complementary efforts may explain other situations where the problem is to avoid bad practices instead of low effort. In public procurement, incumbent firms that have worked for public agencies in the past have more probabilities to be hired in the future as Jofre-Bonet and Pesendorfer (2000) find for highway paving contracts.

This can be interpreted as substitute efforts. However, firms that have not fulfilled obligations relating to the payment of taxes cannot participate in contests. This can be interpreted as complementary efforts.

We consider efforts as profits to be maximized, but these may be considered as wasted costs to be minimized (Epstein et al. 2011 motivates these different situations as different preferences in policies). Given our results, a designer who wants to minimize the efforts in contest stages as a secondary goal after avoiding moral hazard should take into account the past as much as possible.[40] Incentives due to reputation depend on how important the time is in both directions: past and future. Our analysis suggests the bias to use in different situations according to different objectives of the designer: from incentives about agents' effort to unacceptable behaviours.

2.7 Appendix

2.7.1 Proof of Lemma 2.1

In the service stage, the winner of the contest will shirk because the relationship with the designer ends here. Anticipating this, both agents maximize the following expected utilities

$$E(U_i(r,q)) = r\left[q\left(\frac{1}{2}-c\right)+(1-q)(1-c)\right]+(1-r)\left[(1-q)\frac{1}{2}\right], \qquad (2.11)$$

where r (q) is the probability that agent i (j) exerts effort. Taking the derivative, we obtain

$$\frac{\partial E(U_i(r,q))}{\partial r} = \frac{1}{2} - c. \qquad (2.12)$$

The agents' behaviour strategy depends on how expensive the effort is. When it

[40] For instance, a designer might consider to minimize effort in contests because these are polluting. Then, the contest designer's preference over the SPE is $SPEIV \succ SPEIII = SPEVII \succ SPEV \succ SPEI \succ SPEVI \succ SPEII$.

is higher than 1/2, the first derivative is negative and no agent exerts effort. If the cost of effort is lower than 1/2, the first derivative is positive and then both agents exert effort. Finally, when the cost of effort is equal to 1/2, both agents are indifferent between exerting effort or not. Given the symmetric situation, we expect symmetric behaviour strategies with $q = r$.

2.7.2 Proof of Proposition 2.2

In the period 2 service stage, the winner of the period 2 contest stage has no incentive to exert effort because the relationship between him and the designer finishes here. This is repeated in all the subsequent propositions. At the period 2 contest stage, agent w's effective effort depends on his effort at the period 1 service stage. If he shirked, his effective effort is his current effort and Lemma 2.1 describes the period 2 outcome. If, however, agent w exerted effort at the period 1 service stage, his expected utility is

$$E(U_{w,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = r_{w,2}\left[q_{l,2}\left(\frac{2}{3} - c\right) + (1 - q_{l,2})(1 - c)\right] + \\ + (1 - r_{w,2})\left[\frac{q_{l,2}}{2} + (1 - q_{l,2})\right]. \tag{2.13}$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2}, q_{l,2}|x_{w,1} = 1))}{\partial r_{w,2}} = \frac{q_{l,2}}{6} - c. \tag{2.14}$$

Agent l maximizes

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{3} - c\right) + (1 - r_{w,2})\left(\frac{1}{2} - c\right)\right] + \\ + (1 - q_{l,2})[0]. \tag{2.15}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1}=1))}{\partial q_{l,2}} = \frac{1}{2} - c - \frac{r_{w,2}}{6}. \tag{2.16}$$

Both agents' reaction functions imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,0\} & \text{if } c > 1/2 \\ \{0, q_{l,2}\} & \text{if } c = 1/2, \text{ where } q_{l,2} \in [0,1] \\ \{0,1\} & \text{if } 1/6 < c < 1/2 \\ \{r_{w,2}, 1\} & \text{if } c = 1/6, \text{ where } r_{w,2} \in [0,1] \\ \{1,1\} & \text{if } c < 1/6 \end{cases}. \tag{2.17}$$

At the period 1 service stage, the probability of exerting effort by agent w is $x_{w,1}$.[41] He maximizes his expected utility,

$$E(U_{w,1}(x_{w,1})) = x_{w,1}[1 - c + \delta E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1}=1)] + \\ + (1 - x_{w,1})[1 + \delta E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1}=0)]. \tag{2.18}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{w,1}(x_{w,1}))}{\partial x_{w,1}} = \delta \left[E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1}=1) - E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1}=0)\right] - c. \tag{2.19}$$

His behaviour strategy is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} 0 & \text{if } \delta/6 < c < 1/2 \\ [0,1] & \text{if } c = \delta/6 \\ 1 & \text{if } 0 < c < \delta/6 \end{cases}. \tag{2.20}$$

At the period 1 contest stage both agents i, j are equal and their effective efforts are their current efforts by definition. Denote agent i's (j's) probability of exerting

[41] Note that his choice will determine the solution of the period 2 contest stage.

effort at the period 1 contest stage by $r_{i,1}$ ($q_{j,1}$). Given that results of each agent are symmetric, we solve this stage for a representative agent i who maximizes his expected utility

$$\begin{aligned} E(U_{i,1}(r_{i,1}, q_{j,1})) = r_{i,1}q_{j,1}\left(\frac{1}{2}E(U_{w,1}(x_{w,1})) + \frac{\delta}{2}E(U_{l,2}(r_{w,2}, q_{l,2})|x_{w,1}) - c\right) + \\ + r_{i,1}(1-q_{j,1})\left(E(U_{w,1}(x_{w,1})) - c\right) + \\ + (1-r_{w,2})q_{j,1}\left(\delta E(U_{l,2}(r_{w,2}, q_{l,2})|x_{w,1})\right) + \\ + (1-r_{w,2})(1-q_{j,1})\left(\frac{1}{2}E(U_{w,1}(x_{w,1})) + \frac{\delta}{2}E(U_{l,2}(r_{w,2}, q_{l,2})|x_{w,1})\right). \end{aligned} \tag{2.21}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{i,1}(r_{i,1}, q_{j,1}))}{\partial r_{i,1}} = \frac{1}{2}E(U_{w,1}(x_{w,1})) - \frac{\delta}{2}E(U_{l,2}(r_{w,2}, q_{l,2})|x_{w,1}) - c. \tag{2.22}$$

Agent i's response function depends on the cost and it is the following function,

$$r_{i,1}(c) = \begin{cases} 0 & \text{if } c > 1/2 \\ [0,1] & \text{if } c = 1/2 \\ 1 & \text{if } 0 < c < 1/2 \end{cases}. \tag{2.23}$$

Therefore, both agents always exert effort at the period 1 contest stage given the assumption $c < 1/2$. To sum up, now we describe the obtained SPE. For simplicity we use the following notation in order to indicate the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$,

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \delta/6 < c < 1/2 \\ \{(1,1),(x_{w,1}),(1,1),(0)\} & \text{if } c = \delta/6, \text{ where } x_{w,1} \in [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \delta/6 \end{cases}, \tag{2.24}$$

where agent i's expected utility in the period 1 contest stage is

$$E(U_{i,1}(1,1)) = \begin{cases} \frac{1}{2} - c + \delta(\frac{1}{2} - c) & \text{if } \frac{\delta}{6} < c < \frac{1}{2} \\ \frac{1}{2} - c + \delta(\frac{1}{2} - c - \frac{x_{w,1}}{12}) & \text{if } c = \frac{\delta}{6}, \text{ where } x_{w,1} \in [0,1] \\ \frac{1}{2} - \frac{3}{2}c + \delta(1 - 2c) & \text{if } 0 < c < \frac{\delta}{6} \end{cases} . \tag{2.25}$$

2.7.3 Proof of Proposition 2.3

At the period 2 contest stage, agent w's effective effort depends on his effort at the period 1 service stage. If he shirked, his effective effort is his current effort and Lemma 2.1 describes the period 2 outcome. If, however, agent w exerted effort at the period 1 service stage, his expected utility is

$$E(U_{w,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = r_{w,2}\left[q_{l,2}\left(\frac{1+\gamma}{2+\gamma} - c\right) + (1 - q_{l,2})(1-c)\right] + \\ + (1 - r_{w,2})\left[q_{l,2}\left(\frac{\gamma}{1+\gamma}\right) + (1 - q_{l,2})(1)\right]. \tag{2.26}$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2}, q_{l,2}|x_{w,1} = 1))}{\partial r_{w,2}} = \frac{q_{l,2}}{(1+\gamma)(2+\gamma)} - c. \tag{2.27}$$

Agent l maximizes

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{(\gamma+2)} - c\right) + (1 - r_{w,2})\left(\frac{1}{(\gamma+1)} - c\right)\right]. \tag{2.28}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1))}{\partial q_{l,2}} = (\gamma + 2) - c(1+\gamma)(2+\gamma) - r_{w,2}. \tag{2.29}$$

When $\gamma \leq 1$, both agents' reaction functions imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,1\} & \text{if } 1/((1+\gamma)(2+\gamma)) < c < 1/2 \\ \{r_{w,2}, 1\} & \text{if } c = 1/((1+\gamma)(2+\gamma)), \text{ where } r_{w,2} \in [0,1] \\ \{1,1\} & \text{if } 0 < c < 1/((1+\gamma)(2+\gamma)) \end{cases}. \quad (2.30)$$

When $\gamma > 1$, both agents' reaction functions imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,0\} & \text{if } 1/(1+\gamma) < c < 1/2 \\ \{0, q_{l,2}\} & \text{if } c = 1/(1+\gamma), \text{ where } q_{l,2} \in [0,1] \\ \{0,1\} & \text{if } 1/((1+\gamma)(2+\gamma)) < c < 1/(1+\gamma) \\ \{r_{w,2}, 1\} & \text{if } c = 1/((1+\gamma)(2+\gamma)), \text{ where } r_{w,2} \in [0,1] \\ \{1,1\} & \text{if } 0 < c < 1/((1+\gamma)(2+\gamma)) \end{cases}. \quad (2.31)$$

At the period 1 service stage, agent w maximizes his expected utility given equation (2.18). Taking the derivative, which is equation (2.19), his behaviour strategy when $\gamma > 1$ is not to shirk. When $\gamma \leq 1$, his behaviour strategy is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} 0 & \text{if } \gamma/(2\gamma+4) < c < 1/2 \\ [0,1] & \text{if } c = \gamma/(2\gamma+4) \\ 1 & \text{if } 0 < c < \gamma/(2\gamma+4) \end{cases}. \quad (2.32)$$

At the period 1 contest stage both agents maximize their expected utility, which is equation (2.21) when $\delta = 1$. Taking the derivative, equation (2.22), we obtain that the agent i's response function for any $\gamma > 0$ is to compete.

The SPE sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$ when

$\gamma \leq 1$ is

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \frac{\gamma}{(2\gamma+4)} < c < \frac{1}{2} \\ \{(1,1),(x_{w,1}),(1,1),(0)\} & \text{if } c = \frac{\gamma}{(2\gamma+4)}, \text{ where } x_{w,1} \in [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \frac{\gamma}{(2\gamma+4)} \end{cases} . \tag{2.33}$$

And the obtained SPE sequence of efforts on the path when $\gamma > 1$ can be described as

$$\begin{cases} \{(1,1),(1),(0,0),(0)\} & \text{if } \frac{1}{(1+\gamma)} < c < \frac{1}{2} \\ \{(1,1),(1),(0,q_{l,2}),(0)\} & \text{if } c = \frac{1}{(1+\gamma)}, \text{ where } q_{l,2} \in [0,1] \\ \{(1,1),(1),(0,1),(0)\} & \text{if } \frac{1}{((1+\gamma)(2+\gamma))} < c < \frac{1}{(1+\gamma)} \\ \{(1,1),(1),(r_{w,2},1),(0)\} & \text{if } c = \frac{1}{((1+\gamma)(2+\gamma))}, \text{ where } r_{w,2} \in [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \frac{1}{((1+\gamma)(2+\gamma))} \end{cases} . \tag{2.34}$$

2.7.4 Proof of Proposition 2.4

At the period 2 contest stage, Lemma 2.1 describes the period 2 outcome if agent w shirked at the period 1 service stage. Otherwise, his expected utility is

$$E(U_{w,2}(r_{w,2},q_{l,2}|s_{w,1}=1)) = r_{w,2}\left[q_{l,2}\left(\frac{2^{1/\rho}}{2^{1/\rho}+1}-c\right)+(1-q_{l,2})(1-c)\right]+ \\ +(1-r_{w,2})\left[q_{l,2}\left(\frac{1}{2}\right)+(1-q_{l,2})(1)\right]. \tag{2.35}$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2},q_{l,2}|x_{w,1}=1))}{\partial r_{w,2}} = q_{l,2}(2^{1/\rho}-1)-2c(2^{1/\rho}+1). \tag{2.36}$$

Agent l maximizes

$$E(U_{l,2}(r_{w,2},q_{l,2}|s_{w,1}=1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{2^{1/\rho}+1}-c\right)+(1-r_{w,2})\left(\frac{1}{2}-c\right)\right]. \tag{2.37}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1}=1))}{\partial q_{l,2}} = \frac{2^{1/\rho}+1}{2^{1/\rho}-1}(1-2c) - r_{w,2}. \tag{2.38}$$

When $ln(2)/ln(3) \leq \rho \leq 1$, both agents' reaction functions imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,1\} & \text{if } (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) < c < 1/2 \\ \{r_{w,2}, 1\} & \text{if } c = (2^{1/\rho}-1)/(2(2^{1/\rho}+1)), \text{ where } r_{w,2} \in [0,1] \\ \{1,1\} & \text{if } 0 < c < (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) \end{cases} . \tag{2.39}$$

When $0 \leq \rho \leq ln(2)/ln(3)$, both agents' reaction functions imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,1\} & \text{if } (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) < c < 1/2 \\ \{r_{w,2}, 1\} & \text{if } c = (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) \\ \left\{\frac{(2^{1/\rho}+1)(1-2c)}{(2^{1/\rho}-1)}, \frac{2c(2^{1/\rho}+1)}{(2^{1/\rho}-1)}\right\} & \text{if } 1/(2^{1/\rho}+1) < c < (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) \\ \{1, q_{l,2}\} & \text{if } c = 1/(2^{1/\rho}+1) \\ \{1,1\} & \text{if } 0 < c < 1/(2^{1/\rho}+1) \end{cases} . \tag{2.40}$$

At the period 1 service stage, agent w maximizes his expected utility given equation (2.18). His behaviour strategy for any parameter $0 \leq \rho \leq 1$ is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} [0,1] & \text{if } (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) \leq c < 1/2 \\ 1 & \text{if } 0 < c < (2^{1/\rho}-1)/(2(2^{1/\rho}+1)) \end{cases} . \tag{2.41}$$

At the period 1 contest stage both agents maximize their expected utility, which is equation (2.21) when $\delta = 1$. We obtain again that both agents always exert effort at the period 1 contest stage. To sum up, now we describe the obtained SPE through the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$

when $ln(2)/ln(3) \leq \rho \leq 1$,

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))} < c < \frac{1}{2} \text{ and } \delta < 1 \\ \{(1,1),(x_{w,1}),(1,1),(0)\} & \text{if } c = \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))}, \text{ where } x_{w,1} = [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))} \end{cases} . \tag{2.42}$$

And the obtained SPE through the sequence of efforts on the path when $0 < \rho < ln(2)/ln(3)$ can be described as

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))} < c < \frac{1}{2} \text{ and } \delta < 1 \\ \{(1,1),(x_{w,1}),(r_{w,2},1),(0)\} & \text{if } c = \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))}, \text{ where } x_{w,1} = [0,1], r_{w,2} = [\frac{(1-2c)}{(2c)},1] \\ \left\{(1,1),(1),(\frac{(2^{1/\rho}+1)(1-2c)}{(2^{1/\rho}-1)},\frac{2c(2^{1/\rho}+1)}{(2^{1/\rho}-1)}),(0)\right\} & \text{if } \frac{1}{(2^{1/\rho}+1)} < c < \frac{(2^{1/\rho}-1)}{(2(2^{1/\rho}+1))} \\ \{(1,1),(1),(1,q_{l,2}),(0)\} & \text{if } c = \frac{1}{(2^{1/\rho}+1)}, \text{ where } q_{l,2} \in [\frac{2}{(2^{1/\rho}-1)},1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \frac{1}{(2^{1/\rho}+1)} \end{cases} \tag{2.43}$$

.

2.7.5 Proof of Proposition 2.5

At the period 2 contest stage, the agent w's effective effort depends on his effort at the period 1 service stage. If he shirked, his effective effort is zero, his expected utility is equation (2.44) and agent l's expected utility is equation (2.45).

$$E(U_{w,2}(r_{w,2},q_{l,2}|s_{w,1}=0)) = r_{w,2}\left[q_{l,2}(-c)+(1-q_{l,2})(\frac{1}{2}-c)\right]+\frac{(1-r_{w,2})(1-q_{l,2})}{2} \tag{2.44}$$

$$E(U_{l,2}(r_{w,2},q_{l,2}|s_{w,1}=0)) = q_{l,2}\left[1-c\right]+(1-q_{l,2})\left[\frac{1}{2}\right] \tag{2.45}$$

Taking derivatives, we obtain that only agent l competes. If, however, agent w exerted effort at the period 1 service stage, their expected utilities are symmetric,

$$E(U_{w,2}(r_{w,2},q_{l,2}|s_{w,1}=1)) = r_{w,2}\left[q_{l,2}\left(\frac{1}{2}-c\right)+(1-q_{l,2})(1-c)\right]+\frac{(1-r_{w,2})(1-q_{l,2})}{2} \tag{2.46}$$

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{2} - c\right) + (1 - r_{w,2})(1 - c)\right] + \\ + \frac{(1 - q_{l,2})(1 - r_{w,2})}{2}. \quad (2.47)$$

Taking derivatives, we obtain that both agents compete.

At the period 1 service stage, agent w maximizes his expected utility given equation (2.18). His behaviour strategy is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} 1 \text{if } 0 < c < 1/4 \\ [0,1] \text{ if } c = 1/4 \\ 0 \text{if } 1/4 < c < 1/2 \end{cases}. \quad (2.48)$$

At the period 1 contest stage both agents maximize equation equation (2.21) when $\delta = 1$. We obtain that both agents exert effort at the period 1 contest only when $c < 1/4$. Otherwise, no agent exerts effort.

To sum up, now we describe the obtained SPE through the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$,

$$\begin{cases} \{(0,0), (0), (0,1), (0)\} & \text{if } \frac{1}{4} < c < \frac{1}{2} \\ \{(r_{i,1}, q_{j,1}), (x_{w,1}), (1,1), (0)\} & \text{if } c = \frac{1}{4}, \text{ where } x_{w,1} = [0,1] \\ \{(1,1), (1), (1,1), (0)\} & \text{if } 0 < c < \frac{1}{4} \end{cases}. \quad (2.49)$$

2.7.6 Proof of Proposition 2.7

At the period 2 contest stage, first we find the interior solution of the problem. Agent w maximizes his expected utility

$$E(U_{w,2}(\hat{e}_{w,2}, e_{l,2})) = \frac{\hat{e}^r_{w,2}}{\hat{e}^r_{w,2} + e^r_{l,2}} - ce_{w,2}. \quad (2.50)$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(\hat{e}_{w,2}, e_{l,2}))}{\partial e_{w,2}} = \frac{r(\hat{e}_{w,2})^{r-1}\hat{e'}_{w,2} e^r_{l,2}}{(\hat{e}^r_{w,2} + e^r_{l,2})^2} - c, \tag{2.51}$$

where $\hat{e'}_{w,2} = \partial \hat{e}_{w,2}/\partial e_{w,2}$. Agent l maximizes

$$E(U_{l,2}(\hat{e}_{w,2}, e_{l,2})) = \frac{e^r_{l,2}}{\hat{e}^r_{w,2} + e^r_{l,2}} - ce_{l,2}. \tag{2.52}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(\hat{e}_{w,2}, e_{l,2}))}{\partial e_{l,2}} = \frac{re^{r-1}_{l,2}\hat{e}^r_{w,2}}{(\hat{e}^r_{w,2} + e^r_{l,2})^2} - c. \tag{2.53}$$

Isolating the cost in both reaction function and equalizing, we obtain

$$e_{l,2} = \frac{\hat{e}_{w,2}}{\hat{e'}_{w,2}}. \tag{2.54}$$

Taking the first order conditions from equation (2.52) and replacing equation (2.54), we obtain the condition

$$\frac{r}{4c} = \hat{e}_{w,2}. \tag{2.55}$$

Taking equations (2.54) and (2.55) we find the optimal effort agent l

$$\frac{r}{4c} = e^*_{l,2}. \tag{2.56}$$

At the period 1 service stage, agent w maximizes his expected utility

$$E(U_{w,1}(s_{w,1})) = 1 - cs_{w,1} + \delta[\frac{\hat{e}^r_{w,2}}{\hat{e}^r_{w,2} + (\frac{r}{4c})^r} - ce_{w,2}], \tag{2.57}$$

where $\hat{e}_{w,2} = \gamma s_{w,1} + e_{w,2}$. Given the result of equation (2.55), we have

$$e_{w,2} = \frac{r}{4c} - \gamma s_{w,1}. \tag{2.58}$$

Taking into account the last equation, we obtain the following derivative of the expected utility

$$\frac{\partial E(U_{w,1}(s_{w,1}))}{\partial s_{w,1}} = \delta\gamma - 1. \tag{2.59}$$

agent w's behaviour strategy is summarized by the following equation

$$s_{w,1}(\gamma,\delta) = \begin{cases} 0 & \text{if } \delta\gamma \leq 1 \\ \frac{r}{\gamma 4c} & \text{if } \delta\gamma \geq 1 \end{cases}. \tag{2.60}$$

At the period 1 contest stage both agents are equal and maximize their expected utility. When $\delta\gamma \leq 1$, they maximize

$$E(U_{i,1}(e_{i,1},e_{j,1})) = \frac{e_{i,1}^r}{e_{i,1}^r + e_{j,1}^r}\left[1 + \delta(\frac{1}{2} - \frac{r}{4})\right] + \left(1 - \frac{e_{i,1}^r}{e_{i,1}^r + e_{j,1}^r}\right)\delta\left[\frac{1}{2} - \frac{r}{4}\right] - ce_{i,1} \tag{2.61}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{i,1}(e_{i,1},e_{j,1}))}{\partial e_{i,1}} = \frac{re_{i,1}^{r-1}e_{j,1}^r}{(e_{i,1}^r + e_{j,1}^r)^2} - c. \tag{2.62}$$

Assuming that both agents have symmetric behaviour, we find the optimal effort at this stage when $\delta\gamma \leq 1$

$$e_{i,1}^* = \frac{r}{4c}. \tag{2.63}$$

To sum up, now we describe the obtained SPE by the sequence of efforts on the path $\{(e_{i,1},e_{j,1}),(s_{w,1}),(e_{w,2},e_{l,2}),(s_{w,2})\}$ when $\delta\gamma \leq 1$:

$$\left\{\left(\frac{r}{4c},\frac{r}{4c}\right),(0),\left(\frac{r}{4c},\frac{r}{4c}\right),(0)\right\} \tag{2.64}$$

When $\delta\gamma \geq 1$, agents maximize their expected utility at the period 1 contest stage

$$E(U_{i,1}(e_{i,1}, e_{j,1})) = \frac{e_{i,1}^r}{e_{i,1}^r + e_{j,1}^r}\left[1 - \frac{r}{4\gamma} + \frac{\delta}{2}\right] + \left(1 - \frac{e_{i,1}^r}{e_{i,1}^r + e_{j,1}^r}\right)\delta\left[\frac{1}{2} - \frac{r}{4}\right] - ce_{i,1} \tag{2.65}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{i,1}(e_{i,1}, e_{j,1}))}{\partial e_{i,1}} = \frac{re_{i,1}^{r-1}e_{j,1}^r}{(e_{i,1}^r + e_{j,1}^r)^2}\left[1 + \frac{r}{4}\left(\delta - \frac{1}{\gamma}\right)\right] - c. \tag{2.66}$$

Assuming that both agents have symmetric behaviour, we find the optimal effort at this stage when $\delta\gamma \leq 1$

$$e_{i,1}^* = \frac{r}{4c}\left[1 + \frac{r}{4}\left(\delta - \frac{1}{\gamma}\right)\right]. \tag{2.67}$$

To sum up, now we describe the obtained SPE by the sequence of efforts on the path when $\delta\gamma \leq 1$:

$$\left\{\left(\frac{r}{4c}\left[1 + \frac{r}{4}\left(\delta - \frac{1}{\gamma}\right)\right], \frac{r}{4c}\left[1 + \frac{r}{4}\left(\delta - \frac{1}{\gamma}\right)\right]\right), \left(\frac{r}{4\gamma c}\right), \left(0, \frac{r}{4c}\right), (0)\right\} \tag{2.68}$$

2.7.7 Proof of Proposition 2.8

At the period 2 contest stage, the agent w's effective effort depends on his effort at the period 1 service stage. If he shirked, his effective effort is his current effort and Lemma 2.1 describes the period 2 outcome. If, however, agent w exerted effort at the period 1 service stage, his expected utility is

$$E(U_{w,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = r_{w,2}(1 - c) + (1 - r_{w,2})\left[q_{l,2}\left(\frac{1}{2}\right) + (1 - q_{l,2})(1)\right]. \tag{2.69}$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2}, q_{l,2}|x_{w,1} = 1))}{\partial r_{w,2}} = q_{l,2} - 2c. \tag{2.70}$$

Agent l maximizes

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = q_{l,2}\left[r_{w,2}(0-c) + (1-r_{w,2})\left(\frac{1}{2}-c\right)\right]. \tag{2.71}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1))}{\partial q_{l,2}} = 1 - 2c - r_{w,2}. \tag{2.72}$$

When $c < 1/2$, both agents' reaction functions imply

$$(r_{w,2}, q_{l,2}) = (1-2c, 2c). \tag{2.73}$$

At the period 1 service stage, agent w maximizes his expected utility given equation (2.18). His behaviour strategy is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} 0 & \text{if } \delta/2 < c < 1/2 \\ [0,1] & \text{if } c = \delta/2 \\ 1 & \text{if } 0 < c < \delta/2 \end{cases}. \tag{2.74}$$

At the period 1 contest stage both agents maximize equation (2.21) and we obtain that both agents always exert effort at the period 1 contest stage. To sum up, now we describe the obtained SPE through the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$:

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \delta/2 < c < 1/2 \\ \{(1,1),(x_{w,1}),(r_{w,2},q_{l,2}),(0)\} & \text{if } c = \delta/2, \\ & \text{where } x_{w,1} \in [0,1], r_{w,2} \in [1-2c,1], q_{l,2} \in [2c,1] \\ \{(1,1),(1),(1-2c,2c),(0)\} & \text{if } 0 < c < \delta/2 \end{cases} \tag{2.75}$$

2.7.8 Proof of Proposition 2.9

At the period 2 contest stage, results depend on the agent w's effort at the period 1 service stage. If he shirked, all agents are equal and they maximize their expected utility by assuming that the other agents have the same behaviour $q_{j-i,2}$

$$E(U_{i,2}(r_{i,2}, q_{j-i,2}|s_{w,1}=0)) = r_{i,2}\left[q_{j-i,2}\left(\frac{1}{N}-c\right)+(1-q_{j-i,2})(1-c)\right]+ \\ +(1-r_{w,2})\left[q_{j-i,2}\,(0)+(1-q_{j-i,2})(\frac{1}{N})\right]. \tag{2.76}$$

Taking the derivative, we have

$$\frac{\partial E(U_{i,2}(r_{i,2}, q_{j-i,2}|x_{w,1}=0))}{\partial r_{i,2}} = q_{j-i,2}(2-N)+N(1-c)-1, \tag{2.77}$$

where $N>2$. Assuming that all agents are equal, agents' reaction functions imply that they compete as long as $0<c<1/N$.[42] If, however, agent w exerted effort at the period 1 service stage, his expected utility is

$$E(U_{w,2}(r_{w,2}, q_{l,2}|s_{w,1}=1)) = r_{w,2}\left[q_{l,2}\left(\frac{2}{N+1}-c\right)+(1-q_{l,2})(1-c)\right]+ \\ +(1-r_{w,2})\left[q_{l,2}\left(\frac{1}{N}\right)+(1-q_{l,2})(1)\right], \tag{2.78}$$

where $q_{l,2}$ brings together all the losers of the period 1 contest stage and we assume that these agents have the same behaviour. Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2}, q_{l,2}|x_{w,1}=1))}{\partial r_{w,2}} = q_{l,2}(N-1)-cN(N+1). \tag{2.79}$$

Agents l maximize

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1}=1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{N+1}-c\right)+(1-r_{w,2})\left(\frac{1}{N}-c\right)\right]. \tag{2.80}$$

[42]This assumption is equivalent to the assumption $c<1/2$ in the case with two agents.

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1}=1))}{\partial q_{l,2}} = (N+1)(1-cN) - r_{w,2}. \tag{2.81}$$

The reaction functions of both types of agents imply

$$\{r_{w,2}, q_{l,2}\} = \begin{cases} \{0,1\} & \text{if } (N-1)/(N(N+1)) < c < 1/N \\ \{r_{w,2}, 1\} & \text{if } c = (N-1)/(N(N+1)), \text{ where } r_{w,2} \in [0,1] \\ \{1,1\} & \text{if } 0 < c < (N-1)/(N(N+1)) \end{cases} . \tag{2.82}$$

At the period 1 service stage, agent w maximizes his expected utility given equation (2.18). His behaviour strategy is summarized in the following equation,

$$x_{w,1}(c) = \begin{cases} 0 & \text{if } \delta(N-1)/(N(N+1)) < c < 1/N \\ [0,1] & \text{if } c = \delta(N-1)/(N(N+1)) \\ 1 & \text{if } 0 < c < \delta(N-1)/(N(N+1)) \end{cases} . \tag{2.83}$$

At the period 1 contest stage all agents maximize their expected utility, which is equation (2.21), and we obtain again that all agents always exert effort at the period 1 contest stage. To sum up, now we describe the obtained SPE through the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \delta(N-1)/(N(N+1)) < c < 1/N \\ \{(1,1),(x_{w,1}),(1,1),(0)\} & \text{if } c = \delta(N-1)/(N(N+1)), \text{ where } x_{w,1} = [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c < \delta(N-1)/(N(N+1)) \end{cases} . \tag{2.84}$$

2.7.9 Proof of Propositions 2.10 and 2.11

In the period 2 service stage, the winner of the period 2 contest stage shirks. At the period 2 contest stage, the agent w's effective effort depends on his effort at the period 1 service stage. If he shirked, both agents exert effort at the period 2 contest stage when $c_c < 1/2$. If, however, agent w exerted effort at the period 1 service stage, his expected utility is

$$E(U_{w,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = r_{w,2}\left[q_{l,2}\left(\frac{2}{3} - c_c\right) + (1 - q_{l,2})(1 - c_c)\right] +$$
$$(1 - r_{w,2})\left[q_{l,2}\left(\frac{1}{2}\right) + (1 - q_{l,2})(1)\right]. \quad (2.85)$$

Taking the derivative, we have

$$\frac{\partial E(U_{w,2}(r_{w,2}, q_{l,2}|x_{w,1} = 1))}{\partial r_{w,2}} = q_{l,2} - 6c_c. \quad (2.86)$$

Agent l maximizes

$$E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1)) = q_{l,2}\left[r_{w,2}\left(\frac{1}{3} - c_c\right) + (1 - r_{w,2})\left(\frac{1}{(2)} - c_c\right)\right]. \quad (2.87)$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{l,2}(r_{w,2}, q_{l,2}|s_{w,1} = 1))}{\partial q_{l,2}} = 3 - 6c_c - r_{w,2}. \quad (2.88)$$

Both agents' reaction functions imply

$$(r_{w,2}, q_{l,2}) = \begin{cases} (0,1) & \text{if } 1/6 < c_c < 1/2 \\ (r_{w,2}, 1) & \text{if } c_c = 1/6, \text{ where } r_{w,2} \in [0,1] \\ (1,1) & \text{if } 0 < c_c < 1/6 \end{cases}. \quad (2.89)$$

At the period 1 service stage, agent w maximizes his expected utility,

$$E(U_{w,1}(x_{w,1})) = x_{w,1}[1 - c_s + \delta E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1} = 1)] +$$
$$+ (1 - x_{w,1})[1 + \delta E(U_{w,2}(r_{w,2}, q_{l,2})|s_{w,1} = 0)]. \quad (2.90)$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{w,1}(x_{w,1}))}{\partial x_{w,1}} = \delta\left[E(U_{w,2}(r_{w,2},q_{l,2})|s_{w,1}=1) - E(U_{w,2}(r_{w,2},q_{l,2})|s_{w,1}=0)\right] - c_s. \tag{2.91}$$

Results depend on which cost is the highest. When $c_s \geq c_c$, agent w's behaviour strategy is

$$x_{w,1}(c_s) = \begin{cases} 0 & \text{if } \delta/6 < c_s < 1/2 \\ [0,1] & \text{if } c_s = \delta/6 \\ 1 & \text{if } 0 < c_s < \delta/6 \end{cases}. \tag{2.92}$$

When $c_c \geq c_s$, agent w's behaviour strategy is

$$x_{w,1}(c_s,c_c) = \begin{cases} 0 & \text{if both } \delta/6 < c_s < 1/2 \text{ and } 0 < \delta c_c < c_s < 1/2 \\ [0,1] & \text{if either } c_s = \delta/6 < \delta c_c < 1/2 \text{ or } \delta/6 < c_s = \delta c_c < 1/2 \\ 1 & \text{if either } 0 < c_s < \delta/6 \text{ or } \delta/6 \leq c_s < \delta c_c < 1/2 \end{cases}. \tag{2.93}$$

At the period 1 contest stage both agents maximize their expected utility,

$$\begin{aligned} E(U_{i,1}(r_{i,1},q_{j,1})) = {} & r_{i,1}q_{j,1}\left(\frac{1}{2}E(U_{w,1}(x_{w,1})) + \frac{\delta}{2}E(U_{l,2}(r_{w,2},q_{l,2})|x_{w,1}) - c_c\right) + \\ & + r_{i,1}(1-q_{j,1})\left(E(U_{w,1}(x_{w,1})) - c_c\right) + \\ & + (1-r_{w,2})q_{j,1}\left(\delta E(U_{l,2}(r_{w,2},q_{l,2})|x_{w,1})\right) + \\ & + (1-r_{w,2})(1-q_{j,1})\left(\frac{1}{2}E(U_{w,1}(x_{w,1})) + \frac{\delta}{2}E(U_{l,2}(r_{w,2},q_{l,2})|x_{w,1})\right). \end{aligned} \tag{2.94}$$

Taking the derivative, we obtain

$$\frac{\partial E(U_{i,1}(r_{i,1},q_{j,1}))}{\partial r_{i,1}} = \frac{1}{2}E(U_{w,1}(x_{w,1})) - \frac{\delta}{2}E(U_{l,2}(r_{w,2},q_{l,2})|x_{w,1}) - c_c. \tag{2.95}$$

The agents' response function in both cases ($c_c \geq c_s$ and $c_c \leq c_s$) is to compete. Therefore, both agents always exert effort at the period 1 contest stage.

To sum up, now we describe the obtained SPE through the sequence of efforts on the path $\{(r_{i,1}, q_{j,1}), (x_{w,1}), (r_{w,2}, q_{l,2}), (x_{w,2})\}$ when $c_c \leq c_s$ or when both $c_c \geq c_s$ and $\delta c_c < \delta/6$,

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \frac{\delta}{6} < c_s < \frac{1}{2} \\ \{(1,1),(x_{w,1}),(1,1),(0)\} & \text{if } c_s = \frac{\delta}{6}, \text{ where } x_{w,1} \in [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c_s < \frac{\delta}{6} \end{cases} . \tag{2.96}$$

And the obtained SPE through the sequence of efforts on the path when both $c_c \geq c_s$ and $\delta/6 < \delta c_c < 1/2$ can be described as

$$\begin{cases} \{(1,1),(0),(1,1),(0)\} & \text{if } \delta/6 < \delta c_c < c_s < 1/2 \\ \{(1,1),(x_{w,1}),(r_{w,2},1),(0)\} & \text{if } \delta/6 < c_s = \delta c_c < 1/2, \text{ where } r_{w,2}, x_{w,1} \in [0,1] \\ \{(1,1),(1),(0,1),(0)\} & \text{if } \delta/6 < c_s < \delta c_c < 1/2 \\ \{(1,1),(x_{w,1}),(r_{w,2},1),(0)\} & \text{if } \delta/6 < c_s = \delta c_c < 1/2, \text{ where } r_{w,2}, x_{w,1} \in [0,1] \\ \{(1,1),(1),(1,1),(0)\} & \text{if } 0 < c_s < \delta/6 \end{cases} . \tag{2.97}$$

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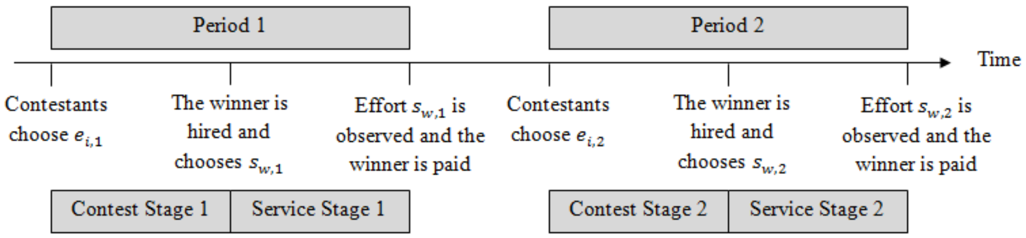

Figure 2.1: Timing of the model.

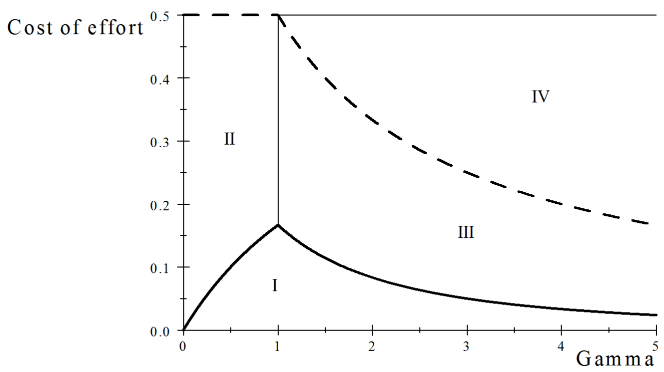

Figure 2.2: Relationship between SPEs, parameter γ and cost of effort for $\delta = 1$.

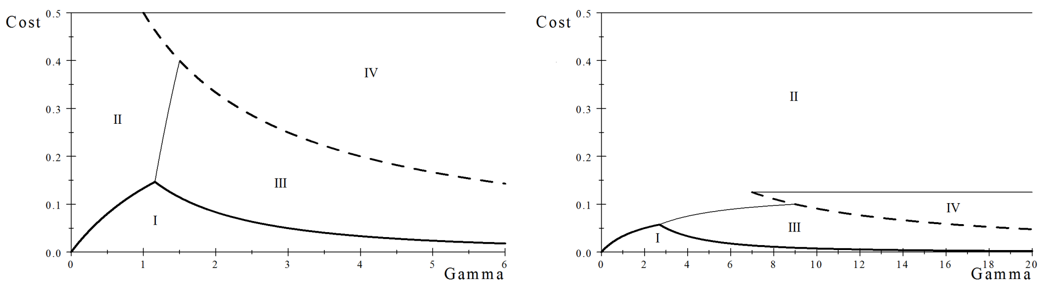

Figure 2.3: Relationship between SPEs, parameter γ and cost of effort when $\delta = 0.8$ (left) and $\delta = 0.2$ (right).

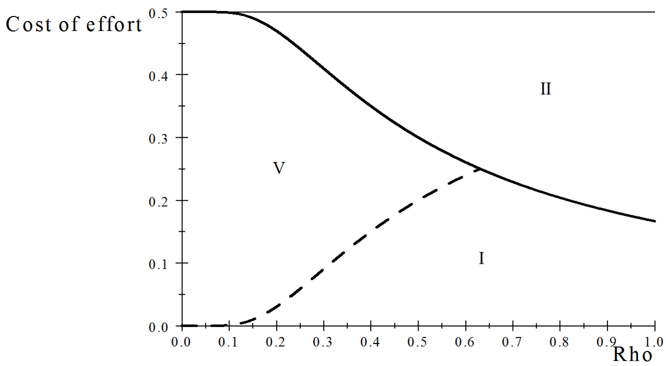

Figure 2.4: Relationship between SPEs, parameter ρ and cost of effort for $\delta = 1$.

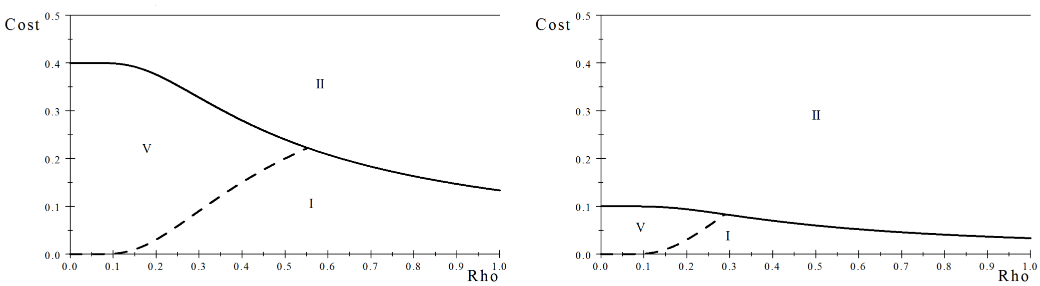

Figure 2.5: Relationship between SPEs, parameter ρ and cost of effort when $\delta = 0.8$ (left) and $\delta = 0.2$ (right).

Chapter 3

Affirmative Action through Extra Prizes for Disadvantaged Minorities

3.1 Introduction

Some affirmative action policies establish that a set of disadvantaged competitors has access to an extra prize. Examples are gender quotas, prizes for national competitors in an international competition, like in film or fireworks awards, or a prize for the best paper by a young scientist. The purpose of the present paper is to investigate the incentive effects of this affirmative action instrument. Our main result is to show that this, from a normative point of view appealing policy, can be desirable on efficiency grounds, increasing thereby its social acceptance.

We analyse the effects of extra prizes in a contest model. These models have been insightful in a variety of competitive situations, including rent-seeking, promotional competition, labor market tournaments, sports competitions or conflict.[1] Following Stein (2002) or Franke et al. (2013), we investigate an asymmetric contest in which contestants differ in ability. Agents with relatively low ability belong to a disadvantaged minority.

A standard result in contest theory says that in a standard contest, without the introduction of affirmative action policies, the most inefficient (or least able) agents might not actively participate in the competition (Stein 2002). And indeed, 'minority representation' is an important concern in real competitions. For instance, in California the Disabled Veteran Business Enterprise and Small Business Certification Programs establish explicit target market shares for these disadvantaged groups. Similarly, the European Union has target shares for female representation on firms' boards. The challenge is then to design affirmative action policies that can reconcile the conflicting aims of reaching both (i) a sufficient level of minority representation and (ii) a sufficient level of competition. Avoiding trade-offs between these objectives is important because it influences the political support for and the prevalence of affirmative action policies. Ayres and Cramton (1996), for example, report that various California ballot initiatives tried to end state-sponsored affirmative action because of the belief that eliminating affirmative action could help to solve budget problems.

In our model the contest designer can create an extra prize at the cost of reducing the prize in the main competition. All contestants compete for the main prize, but only disadvantaged agents can win the extra prize. This fits, for example, quotas for disadvantaged minorities, like gender quotas, in which the establishment of the quota reduces the budget available in the main competition. Disadvantaged agents thus should have an incentive to exert higher effort but it is far from obvious that the overall level of competition will be strengthened, as advantaged agents have lower incentives to invest.

We show that disadvantaged agents indeed do have an incentive to exert higher

[1] For a survey see Konrad (2009).

effort and that we can think of the effects of extra prizes 'as raising the ability of disadvantaged agents'. In this sense extra prizes create a 'level playing field', as the abilities of contestants become more homogeneous. This leads to our first major result that an extra prize is a powerful tool to ensure participation of disadvantaged agents. With an extra prize both groups of agents are active; using the language of the affirmative action literature, there is diversity.

Our main result is to show that extra prizes have the potential to strengthen the overall level of competition. The reason is that, as the disadvantaged minority competes stronger, advantaged agents might compete stronger than they otherwise would, resulting in a higher overall level of competition. More precisely, we show that for intermediate levels of the disadvantage of the minority, introducing an extra prize increases total equilibrium effort compared to a standard contest. By means of simple examples we show that the effect of extra prizes on total effort might potentially be quite important and that this effect might arise with or without an increase in minority representation. Thus, a contest designer might establish an extra prize purely on efficiency grounds.[2]

A distinctive feature of our model is that some agents might win more than one prize with a sole effort choice. This fits quotas, provided that at the time of investment (for example in education) minority members might still choose between participating in the main competition or as a minority member. But there are further situations in which this feature is realistic. For instance, in 2011 the Catalan film *Black Bread* won both the (Spanish) Goya Award and the (Catalan) Gaudí Award in the category of Best Film. Another example is the fireworks contest yearly organized by the City Council of Tarragona. In 2009 a local firm won both the main (international) prize and the prize for Catalan competitors. Currently, in Germany a prominent firm organizes a photo competition that awards a main annual prize

[2] We are not aware of an empirical study that fits exactly our model. Balafoutas and Sutter (2012), however, provide experimental evidence that related (but different) affirmative policies can have an important impact on minority participation, while not harming the efficiency of the competition, as predicted by our model.

and a secondary monthly prize that both can be won with the same photo.[3]

There might, however, be further situations that do not fit our model exactly but for which our model might serve as a benchmark. Consider promotional competition. Firms invest effort in building up brands. These brand names affect the market shares of the firms' products in several markets but not all brands have products in all markets. Consider for instance rent-seeking. Interest groups expend effort in activities including setting up offices close to political decision makers, building up personal networks to legislators, or developing a reputation for competence on specific issues. Lobbies are often affected by divers legislative issues but not all groups have stakes in all issues. A broader implication of our model is that in these situations the model of a standard contest might underestimate the incentives to participate of agents with low stakes, and sometimes even underestimate total effort.[4]

Our paper relates mainly to two strands of literature. The first analyses the incentive effects of affirmative action policies in competitive situations and the second investigates the prize structure in contests.

The present paper shows that extra prizes create a 'level playing field' that may lead to more intense competition. A growing literature has determined other policies that affect competition in a similar way, including subsidies to high-cost suppliers (Ewerhart and Fieseler 2003; Rothkopf et al. 2003), bid preferences and other biases in the selection of the winner (Ayres and Cramton 1996; Franke 2012), share auctions (Alcalde and Dahm 2013), and the handicap or even exclusion of the most efficient participant (Baye et al. 1993; Che and Gale 2003; Kirkegaard 2012).[5]

[3]See www.olympus.de/omd, accessed on 02/08/2013.

[4]There are also situations which might be interpreted as being the opposite to affirmative action, because the most efficient agents have access to extra prizes. Consider (European) soccer teams and their investment in players. All teams compete in the national leagues. In addition, however, the best teams compete in European competitions, like the Champions League.

[5]We comment further on the relationship to Baye et al. (1993) in the concluding section. The creation of a 'level playing field' does not always result in the most intense competition. Perez-Castrillo and Wettstein (2012) analyse innovation contests under asymmetric information. They provide conditions under which in a symmetric setting discrimination among contestants is optimal. Such a discrimination (where the size of the prize depends on the identity of the winner) makes

Since the introduction of an extra prize establishes a specific prize structure, our paper also contributes to the literature on the optimal prize structure in contests (e.g. Glazer and Hassin 1988; Moldovanu and Sela 2001; Moldovanu and Sela 2006; Azmat and Möller 2009; Fu and Lu 2009; Möller 2012). Our model, however, differs from this literature by allowing for some contestants to win more than one prize with a sole effort choice.[6]

The paper is organized as follows. The next section collects our assumptions and fixes notation. We conduct our strategic analysis in Section 3.3. The last section contains concluding remarks. All proofs are relegated to an Appendix.

3.2 Model

A set of risk-neutral contestants $N = \{1, 2, ..., n\}$ competes for a budget B.[7] An agent i's share of the budget depends on his effort exerted, which is denoted by e_i. Expenditures are not recovered. Players have different abilities $\alpha_i > 0$ that are reflected in heterogeneous effort costs $c_i(e_i) = e_i/\alpha_i$. Without loss of generality assume that lower indexed agents have higher ability, so that $\alpha_i \geq \alpha_{i+1}$ for all $i \in \{1, 2, ..., n-1\}$.

There is an observable characteristic that distinguishes agents in such a way that they can be partitioned in two groups, $N = M \cup D$. We interpret D as the disadvantaged group that is the objective of affirmative action. For this reason we assume that agents in $M = \{1, 2, ..., m\}$ have higher ability than agents in $D = \{m+1, ..., n\}$. More precisely, we impose the mild assumption that $\alpha_1 > \alpha_{m+1}$. The agent with

the contest asymmetric and can be thought of as 'the opposite' of the creation of a 'level playing field'.

[6]There are a few models in which a contestant can win multiple prizes. But this requires allocating resources to different contests, as in Gradstein and Nitzan (1989), or choosing effort twice, as in Sela (2012).

[7]In the literature, the outcome of contests has been interpreted to capture either win probabilities or shares of a prize, see Corchón and Dahm (2010). Since we assume that agents are risk neutral, we do not distinguish between both interpretations. Our model thus allows for contestants winning prizes with some probability, as in the case of the aforementioned film awards, or for agents winning shares of a overall budget, as in the case of quotas.

the highest ability is more efficient than the least disadvantaged agent.[8] Otherwise there is no need for affirmative action. To distinguish our setting from a standard contest we suppose $1 \leq m \leq n-2$.

The contest designer aims to maximize total effort. He chooses $\beta \in [0,1)$ in order to divide the budget in two prizes $B_1 = (1-\beta)B$ and $B_2 = \beta B$. Prize B_2 is an extra prize for group D, because while group M only competes for prize B_1, group D competes for both prizes. Notice that although an agent in D exerts effort only once, he might win both prizes. Also, notice that when $\beta = 0$ or $\beta = 1$ we have a standard contest without extra prize.[9] In order to focus on the effects of an extra prize we follow most of the literature and consider for each prize an imperfectly discriminating contest in which an agent i's share of the budget is proportional to his effort expended, see Tullock (1980).[10]

Lastly, we introduce the following notation. The vector of abilities is denoted by $\alpha = (\alpha_1, \alpha_2, \ldots, \alpha_n)$. Given a group of agents G with cardinality $|G|$, the harmonic mean of abilities is given by

$$\Gamma_G \equiv \frac{|G|}{\sum_{k \in G} \frac{1}{\alpha_k}}.$$

Similarly, a vector of individual efforts is denoted by $e = (e_1, e_2, \ldots, e_n)$. Total effort of a group G of agents is $E_G = \sum_{k \in G} e_k$.

3.3 Strategic analysis

The expected payoff of player i is

$$EU_i(e) = \frac{e_i B_1}{E_N} + \frac{e_i B_2 z_i}{E_D} - \frac{e_i}{\alpha_i}, \tag{3.1}$$

[8] We take it as given that minority agents are disadvantaged. See Holzer and Neumark (2000) and Niederle and Vesterlund (2011) for an assessment of the disadvantage in different contexts.

[9] For simplicity of the exposition we exclude the case $\beta = 1$ from most of our derivations. Sometimes, however, it is convenient to include this case. The statements referring to $\beta = 1$ follow from Stein (2002).

[10] We follow most of the literature and assume that when in the competition for a prize none of k agent exerts effort, each agent wins the prize with probability $1/k$.

where $z_i \in \{0, 1\}$ takes value 1 if and only if $i \in D$, and value 0 otherwise. Our first result establishes that contests with extra prizes are a powerful tool to make sure that there will be minority representation, since the extra prize will not be uncontested.

Lemma 3.1. *Let $\beta > 0$. For any (α, B) at least one agent $i \in D$ participates in the contest.*

In order to analyse participation in the contest further, we take the derivative of equation (3.1) and obtain

$$\frac{\partial EU_i(e)}{\partial e_i} = \frac{E_N - e_i}{E_N^2} B_1 + \frac{E_D - e_i}{E_D^2} B_2 z_i - \frac{1}{\alpha_i}. \tag{3.2}$$

Given that (3.1) is concave in e_i, the first-order conditions require that $\partial E_i(e)/\partial e_i = 0$ if $e_i > 0$ and $\partial E_i(e)/\partial e_i \leq 0$ if $e_i = 0$. The former implies that

$$\frac{E_N - e_i}{E_N^2} B_1 + \frac{E_D - e_i}{E_D^2} B_2 z_i = \frac{1}{\alpha_i}. \tag{3.3}$$

Consider the agents in set M. For these agents condition (3.3) reduces to the familiar expression

$$e_i = E_N - \frac{E_N^2}{B_1 \alpha_i}, \tag{3.4}$$

see Stein (2002). This implies that the higher the ability of an agent, the higher his equilibrium effort. If the ability of an agent is low enough, he does not participate. We denote by $m^* \in M$ the agent with $e_{m^*} > 0$ such that for all $i < m^*$, $e_i > 0$ and for all $i \in M$ with $i > m^*$, $e_i = 0$. We denote by $M_{m^*} \subseteq M$ or $M^* \subseteq M$ the set of active advantaged agents, depending on whether we wish to stress the identity of the active agents. If no advantaged agent is active, we set $M^* = \emptyset$ and $m^* = 0$.

Consider the agents in set D. Here condition (3.3) becomes

$$e_i = E_N E_D \frac{B_1 E_D + B_2 E_N - \frac{E_N E_D}{\alpha_i}}{B_1 E_D^2 + B_2 E_N^2}. \tag{3.5}$$

Again, equilibrium effort is ordered by ability. We define $D_{d^*}, D^* \subseteq D$, and d^* analogously to M_{m^*}, M^* and m^*.[11] If no disadvantaged agent is active, we set $D^* = \emptyset$ and $d^* = 0$.

The aim of our strategic analysis is to show that contests with extra prize admit a unique pure strategy equilibrium (a formal statement will be provided in Proposition 3.8), and to investigate the effects of an extra prize on participation (in Subsection 3.3.3) and on total effort (in Subsection 3.3.4). Doing so, however, requires looking first at the two different types of equilibria that might arise. In the first type of equilibrium only one group is active, and behaviour is similar to that in a standard contest. In the second there is diversity and complex effects emerge. We start by analysing each type of equilibrium successively in Subsections 3.3.1 and 3.3.2.

3.3.1 Standard equilibria

There are two situations in which the equilibria that appear in a contest with extra prize are similar to those in a standard contest. The first is the trivial case when $\beta = 0$; when there is no extra prize. In the second the members of the advantaged group are discouraged from participating because the extra prize is sufficiently large. With a large extra prize the prize in the main competition is very small and thus it might happen that $M^* = \emptyset$.[12] In both cases our model reduces to a standard contest that has been analysed by Stein (2002). For our purpose it is sufficient to summarize his results as follows.[13]

Lemma 3.2. *[Stein, 2002] In a standard contest in which a group of agents $P = \{1, 2, \ldots, p\}$ competes for a prize B, the number of active players $|P^*|$ is larger than*

[11] Notice that d^* does not indicate the cardinality of the set of active agents but the index of the most disadvantaged active agent: $|D^*| = d^* - m$.

[12] Notice that if $M^* = \emptyset$, then $E_N = E_D$ and condition (3.5) becomes condition (3.4). The contest with extra prize becomes a standard contest in which only the agents of the disadvantaged group participate.

[13] For the exact expressions of the equilibrium number of active players, individual efforts, win probabilities and expected utilities see Stein (2002).

two and total equilibrium effort is given by

$$E_N = \frac{|P^*| - 1}{|P^*|} B\Gamma_{P^*}. \tag{3.6}$$

In order to describe when standard equilibria appear, it is useful to start with a definition. To do so denote the set of active agents when $M^* = \emptyset$ by $D^*_{M^*=\emptyset}$ and its cardinality by $|D^*_{M^*=\emptyset}|$.

Definition 3.3. Let

$$\overline{\beta} \equiv 1 - \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{1\}}}.$$

Notice that $\Gamma_{\{1\}} = \alpha_1 > 0$ and $|D^*_{M^*=\emptyset}| \geq 2$, implying that $\overline{\beta}$ is well defined. The following result establishes that in any contest, in addition to the trivial case when $\beta = 0$, there are situations in which standard equilibria emerge.

Proposition 3.4. *For any (α, B) the interval $[\overline{\beta}, 1]$ is non-empty. Moreover, for any $\beta \in [\overline{\beta}, 1]$, it is an equilibrium that the set of active agents is $D^*_{M^*=\emptyset}$ and equilibrium behaviour is as in a standard contest for a prize of size B.*

Intuitively, in the equilibria described in Proposition 3.4 the extra prize is too large. It reaches the aim of inducing participation of the disadvantaged group but it does so by discouraging the members of the advantaged group. We turn now to more moderate extra prizes which generate equilibria in which members of both groups are active.

3.3.2 Equilibria with diversity

The following result establishes that when the extra prize is sufficiently small members of both groups are active in equilibrium.

Proposition 3.5. *For any (α, B) the interval $(0, \overline{\beta})$ is non-empty. Moreover, for any $\beta \in (0, \overline{\beta})$, at least one agent of each group participates in the contest.*

In order to describe total equilibrium effort in an equilibrium with diversity, denote the number of active agents in the contest by $|N^*| = |M^*| + |D^*|$.

Proposition 3.6. *For any (α, B), if at least one agent $i \in M$ participates in the contest, then*

$$E_N = \Upsilon + \sqrt{\Upsilon^2 - \Phi}, \tag{3.7}$$

where

$$\begin{aligned} \Upsilon &\equiv \frac{B_1}{2}\left(\frac{|M^*|-1}{|M^*|}\Gamma_{M^*} + \frac{|N^*|-1}{|N^*|}\Gamma_{N^*}\right) \text{ and} \\ \Phi &\equiv \frac{B_1\Gamma_{M^*}\Gamma_{N^*}}{|M^*||N^*|}\left((|N^*|-1)(|M^*|-1)B_1 - (|D^*|-1)B_2\right). \end{aligned}$$

We complete now the description of equilibrium if at least one agent $i \in M$ participates in the contest. Using equation (3.14) in the Appendix, which relates the total equilibrium effort of both groups, we can define the percentage of total effort that is expended by advantaged agents,[14]

$$\Omega \equiv \frac{E_D}{E_N} = |M^*|\frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{B_1\Gamma_{M^*}} - (|M^*| - 1) \in (0, 1).$$

Using expression (3.7) for total equilibrium effort in equation (3.14) we can now determine the total effort of each group as follows

$$\begin{aligned} E_M &= \left(\Upsilon + \sqrt{\Upsilon^2 - \Phi}\right)(1 - \Omega) \\ E_D &= \left(\Upsilon + \sqrt{\Upsilon^2 - \Phi}\right)\Omega. \end{aligned}$$

The expressions for individual efforts of the active agents are obtained as follows.[15]

[14] Notice that Ω is a measure of minority representation. This expression is well defined, as $M^* \neq \emptyset$ implies that $\Gamma_{M^*} > 0$. For all $i \in M^*$ it follows from equation (3.4) that $1/\alpha_i < B_1/E_N$. Summing up over all $i \in M^*$ and rearranging yields $\Omega < 1$. Lastly $\Omega > 0$ is equivalent to $B_1\Gamma_{M^*}(|M^*|-1)/|M^*| < E_N$, which can be shown to hold using equation (3.13) in the Appendix.

[15] When there is no extra prize and $\beta = 0$ both expressions coincide and reduce to the one in Stein (2002). This observation uses the fact, which we will prove in Proposition 3.8, that for $\beta = 0$ equation (3.7) reduces to equation (3.6).

First introducing equation (3.7) in equation (3.4), yielding for $i \in M^*$

$$e_i = \left(\Upsilon + \sqrt{\Upsilon^2 - \Phi}\right)\left(1 - \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{\alpha_i B_1}\right).$$

For $i \in D$ we use equations (3.7) and (3.14) in equation (3.5) obtaining

$$e_i = \left(\Upsilon + \sqrt{\Upsilon^2 - \Phi}\right)\Omega\frac{B_1\Omega\left(1 - \frac{\Upsilon+\sqrt{\Upsilon^2-\Phi}}{\alpha_i B_1}\right) + B_2}{B_1\Omega^2 + B_2}.$$

Since agents of the advantaged group only compete for one prize, only the win probability for prize B_1 is of interest. This is immediately determined. For $i \in M^*$ we have

$$p_i = 1 - \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{\alpha_i B_1}.$$

Members of the disadvantaged group, however, have the chance to obtain two prizes, and thus two win probabilities. The win probability of agent $i \in D^*$ for prize B_1 is

$$p_i = \Omega\frac{B_1\Omega\left(1 - \frac{\Upsilon+\sqrt{\Upsilon^2-\Phi}}{\alpha_i B_1}\right) + B_2}{B_1\Omega^2 + B_2},$$

while the win probability of agent $i \in D^*$ for prize B_2 is

$$q_i = \frac{B_1\Omega\left(1 - \frac{\Upsilon+\sqrt{\Upsilon^2-\Phi}}{\alpha_i B_1}\right) + B_2}{B_1\Omega^2 + B_2}.$$

Lastly we state the expected equilibrium utilities of the active agents. For $i \in M^*$ we have

$$EU_i = B_1\left(1 - \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{\alpha_i B_1}\right)^2,$$

and for $i \in D^*$ one obtains

$$EU_i = \frac{\left[B_1\Omega\left(1 - \frac{\Upsilon+\sqrt{\Upsilon^2-\Phi}}{\alpha_i B_1}\right) + B_2\right]^2}{B_1\Omega^2 + B_2}.$$

3.3.3 The effects of the extra prize on participation

We are now in a position to investigate the effects of the extra prize on participation. Remember that with the help of condition (3.4) we have already established that $e_i > 0$ for $i \in M$ requires sufficient ability

$$\alpha_i > \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{B_1}, \tag{3.8}$$

and thus $e_i > 0$ for $i \in M$ implies $e_j > 0$ for $j < i$. Moreover, for disadvantaged agents a similar property holds; $e_i > 0$ for $i \in D$ requires

$$\alpha_i > \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{B_1} \frac{B_1 \Omega}{B_1 \Omega + B_2}. \tag{3.9}$$

Again $e_i > 0$ for $i \in D$ implies $e_j > 0$ for $m < j < i$. Hence it suffices to characterize candidate sets of active agents by the highest index of the agents in the sets: $M_{m^*} \subseteq M$ and $D_{d^*} \subseteq D$. The overall set of active agents can then be characterized with the help of these two indexes: $N_{d^*}^{m^*} \equiv M_{m^*} \cup D_{d^*}$.[16]

Example 3.1. *Consider $M = \{1, 2\}$ and $D = \{3, 4\}$. Since at least two contestants are active, the candidate sets of active agents are $N_0^2 = \{1, 2\}$, $N_3^1 = \{1, 3\}$, $N_4^0 = \{3, 4\}$, $N_3^2 = \{1, 2, 3\}$, $N_4^1 = \{1, 3, 4\}$, and $N_4^2 = \{1, 2, 3, 4\}$. When $\beta = 0$, Lemma 3.2 allows to exclude N_4^0, N_3^1, and N_4^1. When $\beta > 0$, Proposition 3.5 implies that N_0^2 will not be relevant.*

Lastly, we define for the disadvantaged agents $i \in D$ the effective ability $\hat{\alpha}_i$ as follows

$$\hat{\alpha}_i \equiv \alpha_i \left(1 + \frac{B_2}{B_1 \Omega}\right).$$

We summarize the preceding as

Proposition 3.7. *For any (α, B), the set of active contestants $N_{d^*}^{m^*}$ is found as*

[16] If one of these sets is empty, say $M = \emptyset$, we write $N_0^{d^*}$.

the largest index $m^* = \{0, 1, 2, \ldots, m\}$ *such that, given* d^*,

$$\alpha_{m^*} > \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{B_1} \tag{3.10}$$

holds and the largest index $d^* = \{0, m+1, m+2, \ldots, n\}$ *such that, given* m^*,

$$\hat{\alpha}_{d^*} > \frac{\Upsilon + \sqrt{\Upsilon^2 - \Phi}}{B_1} \tag{3.11}$$

is true. This set of active contestants $N_{d^*}^{m^*}$ *is unique.*

Proposition 3.7 complements Lemma 3.1 and Proposition 3.5. It shows from a different angle that the extra prize might have a strong effect on participation. When $\beta = 0$ and there is no extra prize, effective ability $\hat{\alpha}_i$ is equal to α_i. Disadvantaged agents have the lowest incentives among all contestants to participate, as their ability to compete is lowest. Introducing the extra prize, however, affects the participation conditions of both types of agents.

To see this it is instructive to consider the derivative of the right hand side of both participation conditions (3.10) and (3.11) with respect to β. Since $\partial (E_N/B_1)/\partial\beta > 0$, the extra prize discourages participation of advantaged agents. For disadvantaged agents, however, there is a countervailing effect, because their effective ability $\hat{\alpha}_i$ is also raised, as $\partial (B_2/B_1\Omega)/\partial\beta > 0$.[17]

These two countervailing effects imply that extra prizes have the potential to induce participation of disadvantaged agents who are not active without such a prize and to discourage participation of advantaged agents who are active without such a prize.

[17] In Appendix 3.5.1.6 we provide both derivatives and show that they are positive. Notice that when $E_N/B_1 = \alpha_1$ and the most efficient agent ceases to be active, condition (3.9) becomes condition (3.8).

3.3.4 The effects of the extra prize on total effort

It is convenient to start our analysis summarizing and extending what we know about total equilibrium effort.

Proposition 3.8. *For any (α, B), there is a unique equilibrium.*

- *For $\beta = 0$, there is a standard contest, there might or might not be diversity, and total effort is given by equation (3.6).*
- *For $\beta \in [\overline{\beta}, 1]$, the set of active agents is $D^*_{M^*=\emptyset}$ and total effort is given by equation (3.6).*
- *For $\beta \in (0, \overline{\beta})$, there is diversity and total effort is given by equation (3.7). For $\beta = 0$ and $\beta = \overline{\beta}$, equation (3.7) reduces to equation (3.6).*

Analysing the effects of an extra prize on total equilibrium effort is complicated by the fact that in general equation (3.7) will not be differentiable on $\beta \in (0, \overline{\beta})$. This is so because we cannot rule out that it displays kinks when agents become active or cease to be active. But since for $\beta = 0$ equation (3.7) reduces to equation (3.6) and since by Lemma 3.2 a standard contest among all agents has a higher total effort than a standard contest among disadvantaged agents, we can give a sufficient condition for the optimality of an extra prize by looking at the derivative of equation (3.7) with respect to β at $\beta = 0$.

Given the participation condition (3.4), we can always find β sufficiently close to zero such that the set of active agents will consist of the same set of agents as for $\beta = 0$, except when there was no minority representation (Proposition 3.5). In the latter case, at least the most efficient disadvantaged agent also becomes active. These are the sets of agents to which the next proposition refers.[18]

[18] This can be made precise. Let $M^*_{\beta=0} \subseteq M$ and $D^*_{\beta=0} \subseteq D$ be the sets of advantaged and disadvantaged agents that is active for $\beta = 0$, respectively. Let $D^*_{\alpha_{m+1}} = \{i \in D : \alpha_i = \alpha_{m+1}\}$ be the most able of the disadvantaged agents. Notice that this set has at least cardinality one. The cardinality is higher when there is more than one agent with the highest ability. In the following Proposition, M^* refers to $M^*_{\beta=0}$, D^* refers to $D^*_{\beta=0} \cup D^*_{\alpha_{m+1}}$, and N^* refers to $M^*_{\beta=0} \cup D^*_{\beta=0} \cup D^*_{\alpha_{m+1}}$.

Proposition 3.9. *Let $|M^*| \geq 1$ and $|D^*| \geq 1$ with at least one inequality being strict. The introduction of an extra prize can increase total effort relative to a standard contest if the disadvantage of the minority has an intermediate level, more precisely*

$$\frac{\Gamma_{N^*}}{\Gamma_{M^*}} \begin{cases} > & \left(\frac{|M^*|-1}{|M^*|}\right)^2 \frac{|N^*|}{|N^*|-2} \quad \text{if} \quad \frac{\Gamma_{N^*}}{\Gamma_{M^*}} \leq 1 - \frac{|D^*|}{|M^*|} \frac{1}{|N^*|-1} \\ \\ < & \frac{|N^*|(|N^*|-2)}{(|N^*|-1)^2} \quad \text{if} \quad \frac{\Gamma_{N^*}}{\Gamma_{M^*}} > 1 - \frac{|D^*|}{|M^*|} \frac{1}{|N^*|-1} \end{cases} . \tag{3.12}$$

Why does an extra prize have the potential to increase total effort? The reason is that an extra prize increases the effective ability $\hat{\alpha}_i$ of disadvantaged agents. This balances the competition and results in more intense competition when the disadvantage of the minority is small enough.

We provide now three examples that illustrate that a contest designer might find it beneficial to establish an extra prize. In all examples we normalize $B = 1$.

Example 3.2. *Consider $M = \{1\}$ and $D = \{2, 3\}$. The abilities of the agents are $\alpha = (2, 1/2, 1/2)$. Since at least two contestants are active, the candidate sets of active agents are $N_2^1 = \{1, 2\}$, $N_3^0 = \{2, 3\}$, and $N_3^1 = \{1, 2, 3\}$.*

Consider a standard contest with $\beta = 0$. Since the most efficient agent 1 is active, we are left with N_2^1 and N_3^1. Consider the former. By Lemma 3.2 total effort is $E_{N_2^1} = 2/5$ and by condition (3.10) agent 3 gains by becoming active. Consider N_3^1. Here we have $E_{N_3^1} = 4/9$ and no agent gains from ceasing to be active. Since $\gamma = 0$, condition (3.12) is fulfilled, and we know that the designer gains from establishing an extra prize.

Consider $\beta > 0$. For low extra prizes, by Proposition 3.5, the candidate sets of active agents are N_2^1 and N_3^1. Since the disadvantaged contestants are symmetric and face the same participation condition (3.11), we conclude that all agents are active. By Proposition 3.4, once the extra prize becomes sufficiently large ($\overline{\beta} \geq 7/8$), it does not pay for agent 1 to stay active and total effort is $E_{N_3^0} = 1/4$.

Figure 3.1 shows the effect of the extra prize (horizontal axis) on total effort (vertical axis). Total effort in a standard contest among all agents for the whole prize is indicated by $E_N^{Standard} = E_{N_3^1} = 4/9$. *Total effort with extra prize is indicated by* E_N^{Extra} *and a maximum is reached for* $\beta^* = 0.25$, *where total effort is equal to 1/2. This implies a percentage increase of 12.5% compared to the standard contest.*

Notice that in the previous example minority participation was not affected. Our next example shows that both participation and total effort might be increased through an extra prize.

Example 3.3. *Consider* $M = \{1, 2\}$ *and* $D = \{3, 4\}$. *The abilities of the agents are* $\alpha = (2, 2, 1, 1)$. *The candidate sets of active agents are given in Example 3.1.*

Consider a standard contest with $\beta = 0$. *By the same procedure as in Example 3.2, it is easily determined that the set of active agents is* N_0^2, *because when* $E_{N_0^2} = 1$ *contestants 3 and 4 have no incentive to become active. Since condition (3.12) is fulfilled, establishing an extra prize is beneficial.*

Consider $\beta > 0$. *For small extra prizes, by Proposition 3.5, the candidate sets of active agents are* $N_3^1 = \{1, 3\}$, $N_4^1 = \{1, 3, 4\}$, $N_3^2 = \{1, 2, 3\}$, *and* $N_4^2 = \{1, 2, 3, 4\}$. *Since the contestants in each group are symmetric and face the same participation conditions (3.10) and (3.11), either both are active or none is. Hence the set of active agents is* N_4^2. *By Proposition 3.4, once the extra prize becomes sufficiently large* ($\overline{\beta} \geq 3/4$) *it does not pay for agents 1 and 2 to stay active. In this case total effort is* $E_{N_4^0} = 1/2$.

Figure 3.2 shows the effect of the extra prize on total effort. A maximum is reached for $\beta^* \simeq 0.067$, *implying a percentage increase of almost 8% compared to the standard contest among all agents for the whole prize.*

Our last example shows how an extra prize might stimulate participation, even though there is no gain in terms of total effort.

Example 3.4. *Consider Example 3.3 but decrease the abilities of agents 3 and 4 to 1/2. It is easily verified that condition (3.12) is not fulfilled, implying that establishing an extra prize is not beneficial.*

Consider a standard contest with $\beta = 0$. *The set of active agents is still* N_0^2, *with the same total effort* $E_{N_0^2} = 1$ *and contestants 3 and 4 have even less incentives to become active than in Example 3.3.*

Consider $\beta > 0$. *Again, the candidate set of active agents are* $N_4^0 = \{3, 4\}$ *and* $N_4^2 = \{1, 2, 3, 4\}$, *because of the symmetry of the agents belonging to the same group. Once the extra prize becomes sufficiently large* ($\overline{\beta} \geq 7/8$), *it does not pay for agents 1 and 2 to stay active. In this case total effort is* $E_{N_4^0} = 1/4$.

Figure 3.3 shows that total effort is still strictly concave when there is diversity. But now the maximum is reached for $\beta^* = 0$.

We conclude this section by pointing out that so far we have conducted our analysis under the assumption that the designer does not value minority representation at all. This is so, because we supposed that he is only interested in total effort. Although this is the conservative assumption to make, in the context of affirmative action it is unrealistic. In reality, as in the aforementioned examples of California's Disabled Veteran Business Enterprise and Small Business Certification Programs or the European Union's target shares for female representation on firms' boards, he will be willing to trade-off some effort for minority representation and thus might find it desirable to establish an extra prize.[19]

3.4 Conclusions

This paper analysed the effects of establishing an extra prize for disadvantaged agents in a contest model. Examples of this affirmative action policy are gender

[19] Notice that $1 - \Omega$ measures the win probability of advantaged agents, which declines as the extra prize increases (as $\partial (E_N/B_1) / \partial\beta > 0$). Thus in situations like Example 3.4 the designer can easily balance the trade-off between total effort and minority representation.

quotas or prizes for national competitors in an international competition. We have shown that even very small extra prizes are very effective in making sure that there is minority representation in the competition. Moreover, for intermediate levels of the disadvantage of the minority, establishing an extra prize increases total equilibrium effort compared to a standard contest. Extra prizes might therefore be designed purely on efficiency grounds, which should facilitate the social acceptance of this affirmative action policy.

An important result in contest theory is the exclusion principle, see Baye et al. (1993). This principle applies when the contest success function is responsive enough to effort, as in the all-pay auction (see Baye et al. 1993; Alcalde and Dahm 2007; and Alcalde and Dahm 2010). It says that a contest designer might sometimes strengthen competition and increase total effort by excluding the contestant with the highest valuation from participating in the competition. For the contest success function employed in this paper, however, Fang (2002) has shown that the exclusion principle does not apply. Our analysis allows a deeper understanding of the exclusion principle in our setting. The reason is that establishing an extra prize reduces the main prize and *partially* excludes the most efficient competitor(s). Consistent with Fang (2002), complete exclusion is never beneficial (to see this compare e.g. $\beta = 0$ and $\beta = 1$ in Figure 3.1). *Partial* exclusion, however, might foster competition and increase total effort. In this sense, a *partial* exclusion principle applies to Tullock contests.

In addition to the broad aim of identifying further affirmative action policies that do not entail efficiency costs, our analysis suggests several more specific avenues for future research. A first deepens our understanding of the exclusion principle. Is the desirability of exclusion monotonically linked to the degree with which the contest success function responds to effort? And if so, does this also hold for functions that are not generalizations of Tullock's proposal? Another avenue endows the contest designer not only with the opportunity to create an extra prize but also with the power to choose the contestants that qualify for it. What is the optimal set of agents competing for the extra prize?

3.5 Appendix

3.5.1 Proofs

In this Appendix we provide a proof for the results stated in the main text. In addition to the notation introduced there, we simplify mathematical expressions using

$$\Sigma \equiv \frac{1}{4}\left(\frac{|M^*|-1}{|M^*|}\Gamma^*_M - \frac{|N^*|-1}{|N^*|}\Gamma^*_N\right)^2 + \frac{\Gamma_{M^*}\Gamma_{N^*}}{|M^*||N^*|}(|D^*|-1)\frac{\beta}{1-\beta},$$

and, given a group $G \in \{N, M, D\}$,

$$\Lambda_{G^*} \equiv \frac{|G^*|-1}{|G^*|}\Gamma_{G^*}.$$

We also simplify vectors of individual efforts when we focus on an agent i using the shorter notation $e = (e_i, e_{-i})$, where $e_{-i} = (\dots, e_{i-1}, e_{i+1}, \dots)$.

3.5.1.1 Proof of Lemma 3.1

By way of contradiction let $\beta > 0$ and suppose that there is an equilibrium in which $e_i = 0$ for all agents $i \in D$. Notice that $EU_i(e_i, e_{-i}) = B_2/(n-m)$. Consider the alternative effort $\tilde{e}_i = \epsilon > 0$. This deviation yields

$$EU_i(\tilde{e}_i, e_{-i}) > B_2 - \frac{\epsilon}{\alpha_i}.$$

Since $B_2 - \epsilon/\alpha_i$ is larger than $B_2/(n-m)$ for ϵ small enough, an equilibrium cannot have $e_i = 0$ for all agents $i \in D$. Q.E.D.

3.5.1.2 Proof of Proposition 3.4

Consider the first statement. Since $|D^*_{M^*=\emptyset}| \geq 2$, we have that $\Gamma_{D^*_{M^*=\emptyset}} > 0$. Thus we have $\overline{\beta} < 1$, implying $[\overline{\beta}, 1] \neq \emptyset$.

Consider now the second statement. It follows from Stein (2002) that if $M^* = \emptyset$ no agent $i \in D$ can profitably deviate from the strategies described in the statement. So let the agents $i \in D$ use these strategies and assume that $j \in M$ deviates to $e_j > 0$. Since the payoffs are concave, $\partial E_j(e)/\partial e_j|_{ej=0} > 0$ must hold. This implies $\alpha_j B_1 > E_D$, where $D = D^*_{M^*=\emptyset}$, or equivalently

$$1 - \beta > \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{j\}}}.$$

But since $\alpha_1 \geq \alpha_j$ and $\beta \in [\overline{\beta}, 1]$, we have

$$\frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{j\}}} \geq \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{1\}}} \geq 1 - \beta,$$

a contradiction. Q.E.D.

3.5.1.3 Proof of Proposition 3.5

Consider the first statement. We have that $\overline{\beta} > 0$ if and only if

$$\alpha_1 > \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \Gamma_{D^*_{M^*=\emptyset}}.$$

This inequality holds, because

$$\alpha_1 > \Xi_{D^*_{M^*=\emptyset}} \geq \Gamma_{D^*_{M^*=\emptyset}} > \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \Gamma_{D^*_{M^*=\emptyset}},$$

where $\Xi_{D^*_{M^*=\emptyset}}$ is the arithmetic mean of abilities of the agents in $D^*_{M^*=\emptyset}$.[20] This establishes $(0, \overline{\beta}) \neq \emptyset$.

[20]It is well known that the the arithmetic mean is not smaller than the harmonic mean. For the convenience of the referees we provide a proof in Appendix 3.5.2 (Lemma 3.12). Appendix 3.5.2 is not intended for publication.

Now consider the second statement and suppose $\beta \in (0, \overline{\beta})$. From Lemma 3.1 we know that $D^* \neq \emptyset$. By way of contradiction suppose that $M^* = \emptyset$. Then $e_1 = 0$, implying that $\partial E_1(e)/\partial e_1 \leq 0$ must hold. This implies $\alpha_1 B_1 \leq E_N$. On the other hand, $M^* = \emptyset$ implies that $E_N = E_D$, where $D = D^*_{M^*=\emptyset}$. Therefore the following must hold

$$1 - \beta \leq \frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{1\}}}.$$

Since, however $\beta < \overline{\beta}$ we obtain

$$\frac{|D^*_{M^*=\emptyset}| - 1}{|D^*_{M^*=\emptyset}|} \frac{\Gamma_{D^*_{M^*=\emptyset}}}{\Gamma_{\{1\}}} < 1 - \beta,$$

a contradiction. Q.E.D.

3.5.1.4 Proof of Proposition 3.6

We prove the statement with the help of two lemmatas.

Lemma 3.10. *For any* (α, B) *if* $M^* \neq \emptyset$, *then*

$$E_N \in \{\Upsilon - \sqrt{\Upsilon^2 - \Phi}, \Upsilon + \sqrt{\Upsilon^2 - \Phi}\}.$$

Proof: First notice that the two candidate expressions for E_N are well defined, because we can write

$$\begin{aligned} \Upsilon^2 - \Phi \quad &= \quad \frac{B_1^2}{4} \left(\frac{|M^*| - 1}{|M^*|} \Gamma_{M^*} - \frac{|N^*| - 1}{|N^*|} \Gamma_{N^*} \right)^2 \\ &\quad + \frac{B_1 \Gamma_{M^*} \Gamma_{N^*}}{|M^*||N^*|} (|D^*| - 1) B_2 > 0. \end{aligned} \tag{3.13}$$

Summing up equation (3.3) over all $i \in M$ and rearranging yields

$$E_D = \frac{E_N^2}{B_1} \frac{|M^*|}{\Gamma_{M^*}} - (|M^*| - 1) E_N. \tag{3.14}$$

Summing up equation (3.3) over all $i \in D$, inserting equation (3.14) and rearranging, we obtain the following quadratic equation

$$E_N^2 - E_N 2\Upsilon + \Phi = 0,$$

implying the statement. Q.E.D.

Lemma 3.11. *For any* (α, B) *if* $M^* \neq \emptyset$*, then*

$$E_N \neq \Upsilon - \sqrt{\Upsilon^2 - \Phi}.$$

Proof: Suppose $M^* \neq \emptyset$ and $E_N = \Upsilon - \sqrt{\Upsilon^2 - \Phi}$. Since by equation (3.13)

$$\begin{aligned} \Upsilon^2 - \Phi &> \frac{B_1^2}{4}\left(\frac{|M^*|-1}{|M^*|}\Gamma_{M^*} - \frac{|N^*|-1}{|N^*|}\Gamma_{N^*}\right)^2 \\ &= \frac{B_1^2}{4}\left(\frac{|N^*|-1}{|N^*|}\Gamma_{N^*} - \frac{|M^*|-1}{|M^*|}\Gamma_{M^*}\right)^2, \end{aligned}$$

and the function $f(x) = \sqrt{x}$ is increasing in its argument, we have

$$E_N < \frac{|M^*|-1}{|M^*|}\Gamma_{M^*} B_1. \tag{3.15}$$

From equations (3.14) and (3.15) we have

$$E_D = E_N\left(\frac{E_N}{B_1}\frac{|M^*|}{\Gamma_{M^*}} - (|M^*|-1)\right) < 0, \tag{3.16}$$

contradicting Lemma 3.1. Q.E.D.

Proposition 3.6 follows directly from Lemmatas 3.10 and 3.11. Q.E.D.

3.5.1.5 Proof of Proposition 3.7

It remains to prove uniqueness. Proceeding by contradiction, suppose that for a given β there are two sets of active contestants $H \equiv N_{d-j}^m$ and $J \equiv N_d^{m-k}$. From the preceding it is clear that j and k must both be strictly larger than zero.[21] Moreover, Lemma 3.1 implies that we can focus on $1 \leq k \leq m$ and $1 \leq j < d$. In each equilibrium we indicate total effort by E_H and E_J; and distinguish similarly Ω_H and Ω_J.

In equilibrium H the following participation conditions must hold

$$\alpha_m > \frac{E_H}{B_1}, \quad \alpha_d \leq \frac{E_H}{B_1} \frac{B_1 \Omega_H}{B_1 \Omega_H + B_2},$$

while in equilibrium J we must have, when $k < m$,

$$\alpha_m \leq \frac{E_J}{B_1}, \quad \alpha_d > \frac{E_J}{B_1} \frac{B_1 \Omega_J}{B_1 \Omega_J + B_2},$$

and for $k = m$,

$$\alpha_d > \frac{E_J}{B_1}.$$

Notice that the conditions referring to agent m imply that $E_J > E_H$. We establish now that $\Omega_J > \Omega_H$ holds.

$$\begin{aligned}
\Omega_J - \Omega_H &= m\left(1 - \frac{E_H}{B_1 \Gamma_{N^m_{d-j} \cap M}}\right) - (m-k)\left(1 - \frac{E_J}{B_1 \Gamma_{N^{m-k}_d \cap M}}\right) \\
&= k - \frac{mE_H}{B_1 \Gamma_{N^m_{d-j} \cap M}} + \frac{(m-k)E_J}{B_1 \Gamma_{N^{m-k}_d \cap M}} \\
&> k - \frac{mE_H}{B_1 \Gamma_{N^m_{d-j} \cap M}} + \frac{(m-k)E_H}{B_1 \Gamma_{N^{m-k}_d \cap M}}.
\end{aligned}$$

This last expression is strictly larger than zero if and only if

$$\frac{B_1}{E_H} k - \sum_{i \leq m} \frac{1}{\alpha_i} + \sum_{i \leq m-k} \frac{1}{\alpha_i} = \frac{B_1}{E_H} k - \sum_{i=m-k+1}^{m} \frac{1}{\alpha_i} > 0.$$

Since

$$\sum_{i=m-k+1}^{m} \frac{1}{\alpha_i} \leq k \frac{1}{\alpha_m},$$

[21] If both are zero, the sets are the same. By construction of the sets, given that one is zero, there can not be two largest indexes.

the last expression is implied by the participation condition of agent m in equilibrium H.

Lastly, notice that $E_J > E_H$ and $\Omega_J > \Omega_H$, on one hand, and the participation conditions of agent d in both equilibria, on the other, imply the following. For $k < m$,

$$\alpha_d > \frac{E_J}{B_1}\frac{B_1\Omega_J}{B_1\Omega_J + B_2} > \frac{E_H}{B_1}\frac{B_1\Omega_H}{B_1\Omega_H + B_2} \geq \alpha_d,$$

and for $k = m$,

$$\alpha_d > \frac{E_J}{B_1} > \frac{E_H}{B_1}\frac{B_1\Omega_H}{B_1\Omega_H + B_2} \geq \alpha_d.$$

In both cases we reach the desired contradiction. Q.E.D.

3.5.1.6 The derivatives mentioned in Subsection 3.3.3

Claim 1. $\frac{\partial(E_N/B_1)}{\partial\beta} > 0$.

Proof: We have that

$$\frac{E_N}{B_1} = \frac{1}{2}\left(\frac{|M^*|-1}{|M^*|}\Gamma^*_M + \frac{|N^*|-1}{|N^*|}\Gamma^*_N\right) + \sqrt{\Sigma}.$$

Taking the derivative we obtain

$$\frac{\partial\left(E_N/B_1\right)}{\partial\beta} = \frac{\Gamma_{M^*}\Gamma_{N^*}(|D^*|-1)}{2|M^*||N^*|(1-\beta)^2\sqrt{\Sigma}},$$

which, by Proposition 3.5, is strictly positive. Q.E.D.

Claim 2. $\frac{\partial(B_2/(B_1\Omega)}{\partial\beta} > 0$.

Proof: Using Claim 1, we obtain

$$\frac{\partial\left(\frac{B_2}{B_1\Omega}\right)}{\partial\beta} = \frac{1}{(1-\beta)^2\Omega} - \frac{\beta}{(1-\beta)^3\Omega^2}\frac{\Gamma_{N^*}(|D^*|-1)}{2|N^*|\sqrt{\Sigma}}.$$

For $\beta > 0$, this expression is strictly positive, as $\frac{\partial(B_2/(B_1\Omega)}{\partial\beta} > 0$ if and only if

$$1 - |M^*| + \frac{E_N}{B_1}\frac{|M^*|}{\Gamma_{M^*}} > \frac{\beta}{(1-\beta)}\frac{\Gamma_{N^*}(|D^*|-1)}{2|N^*|\sqrt{\Sigma}}.$$

Introducing E_N/B_1 from Claim 1 and rearranging yields

$$\frac{1}{2}\left(\frac{|N^*|-1}{|N^*|}\Gamma_N^* - \frac{|M^*|-1}{|M^*|}\Gamma_M^*\right) + \sqrt{\Sigma} > \frac{\beta}{(1-\beta)}\frac{|D^*|-1}{2\sqrt{\Sigma}}\frac{\Gamma_{N^*}}{|N^*|}\frac{\Gamma_{M^*}}{|M^*|}.$$

Multiplying by $2\sqrt{\Sigma}$ and collecting terms we obtain

$$\begin{aligned} &\frac{1}{2}\left(\frac{|M^*|-1}{|M^*|}\Gamma_M^* - \frac{|N^*|-1}{|N^*|}\Gamma_N^*\right)^2 + \frac{\beta(|D^*|-1)}{(1-\beta)}\frac{\Gamma_{N^*}}{|N^*|}\frac{\Gamma_{M^*}}{|M^*|} \\ > \quad &\left(\frac{|M^*|-1}{|M^*|}\Gamma_M^* - \frac{|N^*|-1}{|N^*|}\Gamma_N^*\right)\sqrt{\Sigma}. \end{aligned}$$

Squaring and cancelling terms yields finally that $\frac{\partial(B_2/(B_1\Omega)}{\partial\beta} > 0$ if and only if

$$\frac{\beta(|D^*|-1)}{(1-\beta)}\frac{\Gamma_{N^*}}{|N^*|}\frac{\Gamma_{M^*}}{|M^*|} > 0,$$

which, by Proposition 3.5, is strictly positive for $\beta > 0$. Q.E.D.

3.5.1.7 Proof of Proposition 3.8

The statements not implied by our analysis so far are (i) the existence of an equilibrium and (ii) that for $\beta = 0$ and $\beta = \overline{\beta}$ equation (3.7) reduces to equation (3.6).

We start with (i). Notice that for $\beta \notin (0, \overline{\beta})$ existence follows either from Stein (2002) or from Proposition 3.4. Thus consider $\beta \in (0, \overline{\beta})$. The fact that effective abilities are ordered implies that the set of active agents from Proposition 3.7 is consistent in the following sense. On one hand, no active agents wishes to reduce his effort to zero and, on the other, no inactive agent wishes to become active. Moreover, it follows from Proposition 3.5 that the set of active agents always contains at least two agents and is therefore non-empty.

Consider now (ii). For $\beta = 0$, we have that

$$\begin{aligned}\Upsilon^2 - \Phi &= \frac{B_1^2}{4}\left(\frac{|M^*|-1}{|M^*|}\Gamma_{M^*} - \frac{|N^*|-1}{|N^*|}\Gamma_{N^*}\right)^2 \\ &= \frac{B_1^2}{4}\left(\frac{|N^*|-1}{|N^*|}\Gamma_{N^*} - \frac{|M^*|-1}{|M^*|}\Gamma_{M^*}\right)^2,\end{aligned}$$

implying the statement. Consider $\beta = \overline{\beta}$. Take $\beta = \overline{\beta} - \epsilon$, for $\epsilon > 0$ arbitrarily close to zero. If $i \in M^*$ then $\alpha_i = \alpha_1$. This implies that $\Gamma_{M^*} = \alpha_1$. Moreover, for $\beta = \overline{\beta}$ we have that $e_i = 0$ for all $i \in M$ and $|N^*| = |D^*|$ (and $\Gamma_{N^*} = \Gamma_{D^*}$). Using these simplifications and the definition of $\overline{\beta}$ in equation (3.13), we have

$$\begin{aligned}\Upsilon^2 - \Phi &= \left(B\frac{\Lambda_{D^*}}{\alpha_1}\right)^2\left(\frac{1}{4}\Lambda_{M^*}^2 + \frac{\alpha_1^2}{|M^*|} + \frac{1}{4}\Lambda_{D^*}^2 + \frac{1}{2}\Lambda_{M^*}\Lambda_{D^*} - \frac{\alpha_1}{|M^*|}\Lambda_{D^*}\right) \\ &= \left(B\frac{\Lambda_{D^*}}{\alpha_1}\right)^2\frac{1}{4}\left(\frac{(|M^*|+1)}{|M^*|}\alpha_1 - \Lambda_{D^*}\right)^2.\end{aligned}$$

Thus,

$$\begin{aligned}E_N &= \frac{B}{2}\frac{\Lambda_{D^*}}{\alpha_1}\left(\frac{|M^*|-1}{|M^*|}\alpha_1 + \Lambda_{D^*} + \frac{|M^*|+1}{|M^*|}\alpha_1 - \Lambda_{D^*}\right) \\ &= \frac{|D^*|-1}{|D^*|}\Gamma_{D^*}B.\end{aligned}$$

Q.E.D.

3.5.1.8 Proof of Proposition 3.9

Consider $\beta \in (0, \bar{\beta}]$ for which total effort is given by equation (3.7). In order to compute the derivative with respect to β rewrite equation (3.7) as follows

$$E_N = B_1\left[\frac{1}{2}\left(\Lambda_{M^*} + \Lambda_{N^*}\right) + \sqrt{\Sigma}\right].$$

The derivative of total effort with respect to β can then be expressed as

$$\frac{\partial E_N}{\partial \beta} = \frac{\partial B_1}{\partial \beta}\left[\frac{1}{2}\left(\Lambda_{M^*} + \Lambda_{N^*}\right) + \sqrt{\Sigma}\right] + B_1\frac{\partial\left[\frac{1}{2}\left(\Lambda_{M^*} + \Lambda_{N^*}\right) + \sqrt{\Sigma}\right]}{\partial \beta}.$$

Deriving each term and rearranging, we obtain

$$\frac{\partial E_N}{\partial \beta} = \frac{B\Gamma_{N^*}\Gamma_{M^*}(|D^*|-1)}{2(1-\beta)\,|N^*|\,|M^*|\,\sqrt{\Sigma}} - \frac{B}{2}\left(\Lambda_{M^*}+\Lambda_{N^*}\right) - B\sqrt{\Sigma}.$$

Notice that for $\beta = 0$, we have that $\Sigma = \frac{1}{4}\left(\Lambda_{M^*}-\Lambda_{N^*}\right)^2$. This implies that $\partial E_N/\partial\beta|_{\beta=0} > 0$ if and only if

$$\frac{\Gamma_{N^*}\Gamma_{M^*}}{|N^*|\,|M^*|}\left(\left(|D^*|-1\right)+\left(|M^*|-1\right)\left(|N^*|-1\right)\right) > \Lambda^2_{M^*}.$$

Since $|N^*| = |M^*| + |D^*| > 2$,

$$(|D^*|-1)+(|M^*|-1)(|N^*|-1) = |M^*|\,(|N^*|-2) > 0$$

and the previous expression can be rewritten as,

$$\frac{\Gamma_{N^*}}{\Gamma_{M^*}} > \frac{\frac{|M^*|-1}{|M^*|}}{\frac{|N^*|-2}{|N^*|-1}}\frac{\frac{|M^*|-1}{|M^*|}}{\frac{|N^*|-1}{|N^*|}} = \frac{\frac{|M^*|-1}{|M^*|}}{\frac{|M^*|+|D^*|-2}{|M^*|+|D^*|-1}}\frac{\frac{|M^*|-1}{|M^*|}}{\frac{|M^*|+|D^*|-1}{|M^*|+|D^*|}}. \tag{3.17}$$

Consider the function

$$f(x,y) = \frac{x+y-1}{x+y}.$$

The fact that $f(x,y)$ is strictly increasing in both arguments together with Proposition 3.5 imply that the right hand side of (3.17) is largest for $|D^*| = 1$. Moreover for $|D^*| = 1$ the right hand side of (3.17) is strictly smaller than one. This implies the statement. Q.E.D.

3.5.2 On the harmonic mean

This appendix is for the convenience of the referees and not intended for publication. We provide some results on the harmonic mean that we use in the analysis. The first result says that the arithmetic mean Ξ_N of abilities of a set of agents N is not smaller than the harmonic mean Γ_N. The second provides a condition when the harmonic mean increases as the result of increasing the set of agents.

Notice that, under the assumption made in the main text that $\alpha_1 > \alpha_{m+1}$, analogous reasoning to the proof of Lemma 3.13 allows to conclude that the left hand side of condition (3.12) is strictly smaller than one.

Lemma 3.12. $\Xi_N \geq \Gamma_N$.

Proof: In order to use Cauchy's Inequality redefine $\alpha = \lambda^2$. We have that

$$\Xi_N = \frac{1}{n}\sum_{i\in N}\lambda_i^2 \geq \frac{n}{\sum_{i\in N}\frac{1}{\lambda_i^2}} = \Gamma_N$$

if and only if

$$n^2 \leq \left(\sum_{i\in N}\lambda_i^2\right)\left(\sum_{i\in N}\frac{1}{\lambda_i^2}\right).$$

This holds, since Cauchy's Inequality implies that

$$\left(\sum_{i\in N}\lambda_i^2\right)\left(\sum_{i\in N}\frac{1}{\lambda_i^2}\right) \geq \left(\sum_{i\in N}\frac{\lambda_i}{\lambda_i}\right)^2 = n^2.$$

Q.E.D.

We give now a condition that assures that the harmonic mean is increasing when further contestants are added. The condition can be interpreted as saying that contestant i's effort costs must be smaller than average effort costs.[22]

Lemma 3.13. *The harmonic mean of a set of agents $N = \{1, 2, ..., n\}$ increases with i, that is,*

$$\Gamma_N \geq \Gamma_{N\setminus i}$$

if and only if contestant i's ability is higher than the harmonic mean of the other

[22] More precisely,

$$\frac{\frac{1}{\alpha_1}+\frac{1}{\alpha_2}+\cdots+\frac{1}{\alpha_{i-1}}+\frac{1}{\alpha_{i+1}}+\cdots+\frac{1}{\alpha_n}}{n-1} \geq \frac{1}{\alpha_i}.$$

contestants' abilities

$$\alpha_i \geq \Gamma_{N \setminus i}.$$

Proof: We have that

$$\Gamma_N = \frac{n}{\sum_{j \in N} \frac{1}{\alpha_j}} \geq \frac{n-1}{\sum_{j \in N \setminus i} \frac{1}{\alpha_j}} = \Gamma_{N \setminus i}$$

if and only if

$$\frac{1}{\alpha_1} + \frac{1}{\alpha_2} + \cdots + \frac{1}{\alpha_{i-1}} + \frac{1}{\alpha_{i+1}} + \cdots + \frac{1}{\alpha_n} \geq \frac{n-1}{\alpha_i}.$$

Rearranging yields the statement. Q.E.D.

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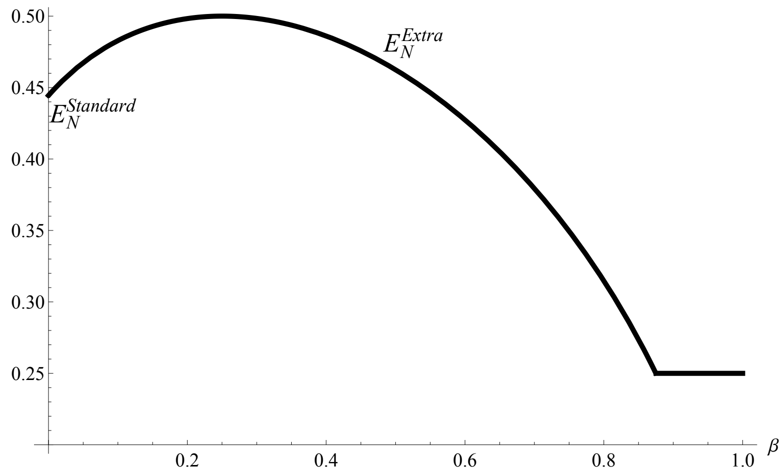

Figure 3.1: Total effort in Example 3.2.

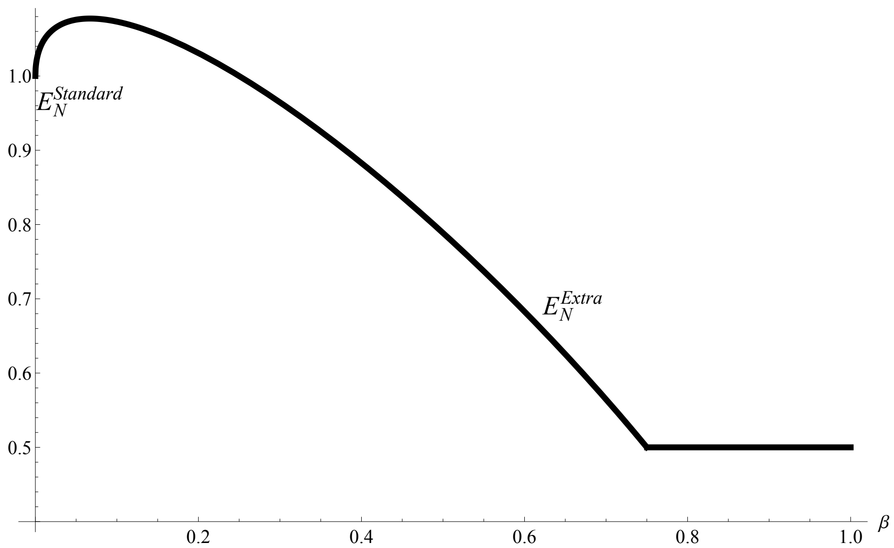

Figure 3.2: Total effort in Example 3.3

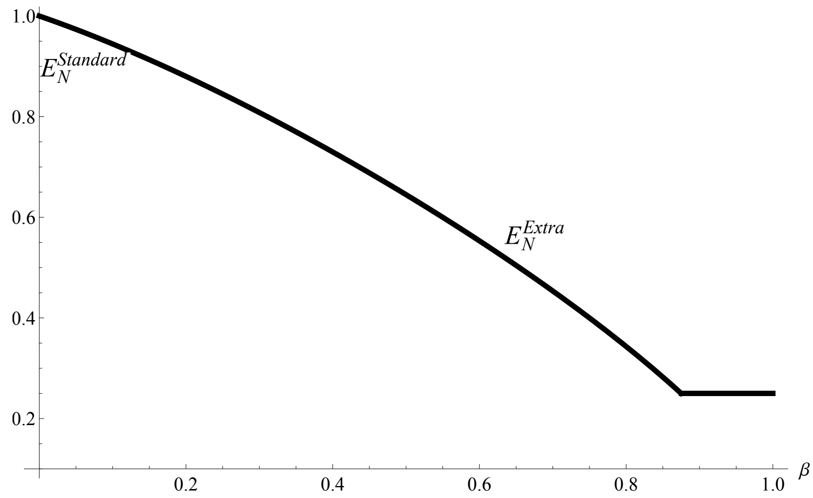

Figure 3.3: Total effort in Example 3.4.

Chapter 4

European Integration: Partisan Motives or Economic Benefits?

4.1 Introduction

The European Union (EU) represents a unique process of economic and political integration in the recent history. Never since World War II we have observed that souvereign countries have renounced to such a great extent their competences on economic and political issues as in the process of the European integration. During most part of this integration process there seemed to have been a more or less common consensus on that more integration was beneficial for all of its members. As a consequence, the European Union has assumed more and more competences from its member countries and has steadily won new members. So, the EU has grown from 6 countries in 1952 to 28 in 2013. However, recently skeptisms on the benefits of European integration has grown in many member countries. For example, in 2005, France and the Netherlands rejected in the referendum the EU constitution. As a consequence, a referendum on the EU constitution in other six EU member countries has been cancelled or postponed indefinitely. In Spain, recently, the supporters to the EU have become the minority for the first time.[1] In the UK, the Conservative party of David Cameron is even questioning EU membership and planning a referendum in 2018. One might argue that this increased skeptism is related to the economic crisis that started in 2008. However, it might also be the case that economic factors have played an important role in European integration from its beginning and, therefore, have determined partisan support to European integration. In this chapter for the first time we examine whether economic factors indeed have influenced partisan positions towards European integration over the last three decades.

That something has changed in partisan support to European integration becomes very clear from Figure 1 that displays the mean partisan support in European countries from 1984 to 2010. From this figure, two main observations come at hand. First, we observe that partisan support is rather heterogenously distributed over European countries. This is especially the case in 1984 and 1988 where partisan attitude towards the European integration, on average, is lower in small peripheral countries like Portugal, Ireland and the Scandinavian countries and higher in large central European countries as, for example, Germany, France, the UK, Spain and Italy. Second, we find that mean partisan support has increased in almost all countries from 1988 to 2002, after which this position has started to decrease, except in new EU member countries. Since changes in partisan constitutions, that have been used as the main explantory variables for partisan support to European integration in the literature until now (c.f., Marks et al. 2002, or Hellström 2008), are unlikely to be the causes for this change, from the tendencies observed in Figure 1, the search for other determinants of partisan support comes right at hand. Naturally, economic factors whose importance is analysed in this chapter might have played a prominant role.

To uncover the partisan and economic determinants that have driven partisan sup-

[1] See Pew Research Center (2013), a summary of the 2013 Spring Pew Global Attitudes Survey.

port to European integration over the last three decades, we use data from 297 political parties of 24 countries collected in eight waves from 1984 to 2010 to test six hypotheses, four of which exclusively refer to the influence of economic factors. The other two hypotheses refer to partisan determinants that have found to influence on partisan contestation over European integration, for example, in Marks et al. (2002) and Hellström (2008) among others. Regarding the hypotheses concerned with the economic determinants, we analyse whether benefits that countries have obtained from the EU, either directly or indirectly, have influenced partisan support for European integration in these countries. Furthermore, we test whether European regulation, the size of welfare states or the business cycle have affected partisan support.

Our results indicate that indeed economic factors have influenced partisan support to European integration in several ways. So, partisan support is larger in relatively poorer countries that are supposed to obtain higher benefits from EU membership. On the other hand, partisan support decreases in those countries that were affected by the Maastricht criteria which indicates that parties worry about losing their influence on national fiscal policies when their countries are controlled by European institutions. Finally, we find that partisan support is positively related to periods of economic growth. Moreover, dividing our sample period in two subsample periods shows that the relevance of economic factors has grown over time. Dividing the sample according to partisan ideology shows that economic motives seem to be more important in determining the support to European integration for left-wing parties than for right-wing parties.

As mentioned before, the literature has not addressed the question whether partisan contestation over European integration is influenced by economic factors.[2] Instead,

[2]However, recently some authors have studied the determinants of public opinion on the European integration process (Garry and Tilley 2009; Hooghe and Marks 2004; McLaren 2004; Anderson and Reichert 1996) and have also considered economic factors, both at the individual and the national level. The analysis shows the existence of a positive relationship between citizens' support to European integration and the national economic perceptions of the population. Moreover, while citizens from countries with higher income per capita are more skeptical, citizens from countries that receive benefits from both net EU transfers and intra-EU trade are more prone to European

the literature has focused basically on two kind of partisan determinants. The first factor is partisan ideology, which has been found to be related to parties' positioning on European integration according to an inverted U-relationship, with central parties being pro-integrationist and extrem parties being Euro-skeptical (Aspinwall 2002; Hellström 2008; Hix 1999; Hix and Lord 1997; Hooghe and Marks 1999; Hooghe et al. 2002; Marks and Steenbergen 2002; Marks and Wilson 2000; Marks et al. 2002). The second kind of partisan factors that have been taken into account are related to strategic electoral responses of parties. While well-estabished ideologically centrally located parties follow the mainstream and take median voter positions on European integration, peripheral parties try to attract unsatisfied voters by taking more radical positions on this issue (Hellström 2008). Thus, parties in government are found to be more pro-integrationist than parties in the opposition. The same is true for parties with more electoral success (Marks et al. 2002, Hellström 2008). On the contrary, extreme parties are found to be more skeptical on European integration. We confirmed these results in our work even though it includes a larger sample regarding its time, country and partisan dimension.

The remainder of this chapter is organized as follows. Section 4.2 motivates the hypotheses subjected to empirical testing. Section 4.3 introduces the data and outlines the estimation procedure. Results are discusssed in Section 4.4. Finally, in Section 4.5 the results are summarized and their relevance is discussed.

4.2 Hypotheses

The literature has addressed political parties' contestation over European integration exclusively to ideological and strategic electoral competition motives (Aspinwall 2002; Hellström 2008; Hix 1999; Hix and Lord 1997; Hooghe and Marks 1999; Hooghe et al. 2002; Marks and Steenbergen 2002; Marks and Wilson 2000; Marks et al. 2002). In this chapter we extend the analysis of the determinants of partisan

integration.

positioning regarding European integration by including economic factors that, as recent developments suggest, seem to have become of growing importance. Our main research question is whether advances in European integration are subjected to the economic development of its member countries and the economic benefits that member countries obtain from such an integration.

Our analysis is based on three sets of hypotheses with two hypotheses formulated for each set. The first set of hypotheses refers to the ideological and strategic electoral motives that already have been analysed in the literature. The first hypothesis follows Marks et al. (2002) in assuming that parties are organizations with embedded ideologies that are grounded on 'Weltanschauungen' that constitute the basis for their positioning towards European integration. Especially, regarding the issue of European integration, partisan positioning is often related to the historical role that parties played in this integration process. According to the literature, partisan contestation over European integration can be located in a two dimensional space (Hooghe and Marks 1999; Hooghe et al. 2010; Marks and Steenbergen 2002; Marks and Steenbergen 2004; Marks and Wilson 2002; Marks et al. 2002; Hellström 2008). While one dimension measures parties' economic position on market organization (from 'regulated capitalism' to 'neo-liberalism'), the other considers the degree of centralization of decision making (from regionalism to a supranationalism). While these two dimensions in principle are independent, they are sometimes closely related to each other and highly correlated to the partisan position on an ideological left/right dimension. For example, we find that extreme left and extreme right parties are strongly opposed to European integration; social democratic and coservative parties are generally moderately in favor; and liberal parties are strongly in favor of European integration (Hellström 2008; Marks et al. 2002). According to this, our first hypothesis is:

H1: Ideology determines the partisan position regarding European integration.

The second hypothesis takes account of partisan competition and the fact that a parties' final objective is its reelection to be able to apply its policies. According to Hix and Lord (1997) and Taggart (1998), major parties support European integration because the positioning in favor of mainstream policy issues allows them to minimize intra-party tensions. So, these parties protect the status quo with a neutral position on 'new issues' such as the European integration (Marks et al. 2002). Minor parties take advantage of the resulting convergence of the policy positions of major parties by formulating extreme positions on European integration in an attempt to attract votes from Euro-skepticals. Following Marks et al. (2002), we use three indicators to see whether strategic electoral motives influence partisan positioning on European integration. First, if major parties are more pro-European we would expect that support for European integration increases with the share of votes that parties obtain in general elections. Second, parties in government should be expected to have a more favorable position towards European integration than parties that are excluded from government, since the former can be made more responsible for the current state of European integration. Finally, parties located at the extremes on an ideological left/right dimension can also be expected to take more extreme positions regarding European integration. Resuming this, the second hypothesis we formulate is:

H2: Partisan postitioning on European integration follows strategic electoral motives.

Our second set of hypotheses considers the economic dimension of European integration. Specifically, we analyse whether the economic costs and benefits of European integration have an influence on partisan positioning in favor or against EU integration in different member countries. Hypothesis three takes account of the direct economic benefits. There are different ways to measure these benefits. First, we consider the difference between the member countries' contribution payments to the EU budget and the expenditure of the EU in these countries. While these (net) expenditures are obviously only a part of the economic benefits from EU membership, there are several reasons to take them into account. On the one hand, both the contributions to the EU budget and the EU expenditures in member countries are the result of extensive negotiations between member states. For example, the UK corrections which reduces the contributions of the UK to the EU budget was agreed by the 1984 Fontainebleau European Council after long negotiations between all member countries. As a result of these negotiations, their press coverage and their role in national elections, voters in member countries are quite aware of the financial benefits and costs of EU integration. Therefore, the position of the median voter regarding EU integration should depend on these benefits and costs which ultimately also affects the partisan position towards EU integration. On the other hand, because of limited rationality, voters tend to value higher the direct than the indirect costs and benefits of European integration which are furthermore much more difficult to measure. As a consequence, both voters and parties will give more importance to the financial costs and benefits than to other kinds of advantages and disadvantages from European integration.

Another important advance in European integration has been the creation of the European Monetary Union (EMU). An important argument in favor of the EMU has been that the creation of a common market with a common currency increases trade among EMU member countries. According to Frankel and Rose (2002), the formation of a currency union allows member countries to triple trade with other currency member countries without diversing trade from nonmember countries. Furthermore, they find that a percent increase in total trade raises income per capita by one-third of a percent in the mid-run. This means that the economic benefits from the EMU should be expected to be substantial at least for large and centrally located economies that according to the gravity model of trade should obtain the largest benefits. Therefore, as a second measure of economic benefits, we consider a country's benefits from EMU induced trade which should be positively related to the positioning in favor of EU integration of the parties in these countries.

Finally, more European integration should lead to a convergence of EU member countries. Such an economic convergence should benefit in first place those countries that are below the mean per capita European income. Consequently, we should expect more support to European integration by parties in relatively 'poor' countries than by parties in relatively 'rich' countries. Our third hypothesis is:

H3: Parties' postitioning regarding European integration depends on the economic benefits from EU integration of the party's country.

As mentioned before, European integration comes along with a centralization of decision making. New supranational institutions assume competences that formerly belonged to the member state governments and, therefore, were under the control of national parties. This has especially affected economic competences. The Maastricht criteria in 1992 were a first attempt to control government deficits and debt and thereby government spending at the national level. Another example is the creation of the EMU and the introduction of the euro which delegated the control of the monetary policy in EMU member countries from national institutions to a supranational institution. With hypothesis four we analyse whether partisan positions regarding European integration have changed in countries that have seen themselves to be especially affected by the control of supranational European institutions. To this extent we use the Maastricht criteria as they are in the center of our sample period and therefore allow to control whether they had a significant influence on partisan positioning towards European integration in countries that did not fulfill the three percent deficit, the 60 percent debt criteria, or both of them. Resuming this, our fourth hypothesis reads as:

H4: The creation of European institutions that assume national competences and limit the partisan influence on formerly national policy issues reduces partisan support to European integration.

Our third set of hypotheses takes account of the country's economic situation. Hypothesis five examines whether there exists a relationship between national advances in the welfare state and partisan support to European integration. As European integration means a convergence of member economies, we could interpret advances in European integration as a reduction of welfare differences among EU member states. Therefore, the population in countries with more advanced welfare states could be expected to be also more prone to a reduction of welfare differences among countries. Accordingly, our fifth hypothesis is:

H5: In countries with a larger welfare state parties are more prone to European integration.

Finally, with hypothesis six we look for an influence of the business cycle on parties' contestation over European integration. As economic integration might come along with costs for some member countries, we could expect that the acceptance of these costs is larger in years in which the national economy goes fine than in 'bad years'. Therefore, for a given country we should observe partisan contestation over European integration to be more positive in years of expansion with positive and high GDP growth rates than in recession years. We formulate this as:

H6: Parties postition regarding EU integration depends on the country's business cycle.

4.3 Data description and methodology

Our analysis is based on the Chapell Hill Expert Survey which merges three datasets: Bakker et al. (2012), Hooghe et al. (2010) and Ray (1999). We use the data from eight waves of surveys (1984, 1988, 1992, 1996, 1999, 2002, 2006 and 2010) for 24 member states of the European Union (Belgium, Denmark, Germany, Greece, Spain, France, Ireland, Italy, Netherlands, United Kingdom, Portugal, Austria, Finland and Sweden for all years; Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia since 2002; and Estonia since 2006).[3] The Chapell Hill Expert Survey contains evaluations of political scientists (experts) about partisan positions regarding European integration of major and minor parties in the experts' native country. The number of experts' responses depends on the year of the survey and goes from 135 in 1984, with an average of 8 experts per country, to 343 in the 2010 survey, with an average of 12 experts per country. As parties enter and exit, and due to the inclusion of serveral countries after 2002, our database is an unbalanced panel with a total of 297 different parties and 1164 observations with approximately 10 parties per country and year.[4] The estimation method is panel data regression with fixed effects.

Our dependent variable is partisan contestation on European integration and measures parties' position towards the European integration process in the year of the survey as the mean of the experts' individual rankings. *European integration* is a categorical variable that goes from 1, strongly opposed, to 7, strongly in favour. Although experts' answers are integer numbers, our dependent variable, as the mean of their evaluations, normally is not an integer.

Our explanatory variables can be arranged into six groups according to our six hypotheses. To test hypothesis 1, as in Hellström (2008) we use *Ideology* and, as in Marks et al. (2002), partisan family. *Ideology* is a categorical variable that measures parties' ideological position from 0, extreme left, to 10, extreme right. As in Hellström (2008), we also consider this variable in squared form (*Ideology Squared*), since the relationship between partisan support to European integration and ideology is non-linear (radical parties on both ends of the ideological spectrum tend to be more Euro-skeptical than central parties). Further partisan characterisitics are measured by dichotomous variables for ten partisan families: *Radical Right*, *Conservative*, *Liberal*, *Christian Democratic*, *Socialist*, *Radical Left*, *Green*, *Re-*

[3]Notice that we extracted the data of these surveys in January 2013 when the 2010 survey was already published but not completely finished. In the Appendix we give more details on how we treated the observations for 2010 and missing values, in general.

[4]See Bakker et al. (2012), Hooghe et al. (2010) and Ray (1999) for more details on the distribution of parties over countries and years.

gionalist/Ethnic, *Confessional*, *Agrarian*, and *No Family*. Hypothesis 2 is tested with two variables, *Electoral Support* and *Government Participation*, which also have been used by Marks et al. (2002) and Hellström (2008). *Electoral support* is measured as parties' share of total votes in the last national parliamentary elections before the survey year in percentage points.[5] *Government participation* is a dummy which takes value one for parties that are in office during the year of the survey.[6]

Hypothesis 3 is contrasted with three different variables, *Relative Income*, *EU Net Expenditure* and *Trade Benefits*. *Relative Income* takes the difference between countries real per capita income and the EU mean (in thousands of euro and purchasing power parity implied prices with 2000 as base year). *EU Net Expenditure* is the difference between a country's contributions to the EU budget and the EU expenditure in this country.[7] It is measured as share of GDP in percentage points. *Trade Benefits* are the benefits from EMU membership induced trade as share of GDP and quoted in percentage points.[8] To calculate *Trade Benefits* we first estimate the linear trend in trade per GDP between EMU member countries for each of these countries before the introduction of the euro (from 1995 to 2001). Then, we calculate the differences between the observed trade and a forecasted trade for a ficticious scenario without the euro based on our trend estimates for the period before 2001.[9] Finally, following Frankel and Rose (2002) who estimated the welfare

[5]Notice that this variable is different from a similar variable considered by Hellström (2008), where it is measured as the increment of votes in the last elections.

[6]Though *Government Participation* is a dichotomous variable that takes value 1 when the party is in government and 0 otherwise, it can also take value 0.5 (for both outgoing parties and entering parties) if there is a change of government in the survey year. Notice also that we measure *Government Participation* differently from Marks et al. (2002). Their variable takes value one when a party has participated in government at least once in the period 1965-1995.

[7]We also include in *EU Net Expenditure* transfers from the EU to Bulgaria, Czech Republic, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia before that these countries were EU members.

[8]Notice that measuring trade as a share of GDP allows to account automatically for business cycle fluctuations.

[9]The estimated effects of EMU induced trade are in line with the predictions of the gravity model. Thus, we obtain highest trade benefits for centrally located and large economies (Germany), medium benefits for small centrally located economies (Austria, Belgium, Luxembourg, Netherlands) and large but more peripheral economies (France, Italy, Spain) and nearly no benefits for small peripheral countries (Finland, Greece, Ireland, Portugal). Furthermore, for a control group of EMU non-member countries (Denmark, Sweden, UK), there are no effects of EMU induced trade.

effects of currency unions, we assume that a one percent increase in a country's overall trade (relative to GDP) raises income per capita by at least one-third of a percent. Per definition, *Trade Benefits* for EMU non-members are zero. We consider *Trade Benefits* after the adoption of the euro, i.e., when a country introduces euro banknotes and coins.

To test hypothesis 4, we use two different type of variables. *Maastricht Debt Non-Compliance*, *Maastricht Deficit Non-Compliance*, and *Maastricht Debt and Deficit Non-Compliance* are dummy variables that take value one when the country's government debt exceeds 60% of GDP, when government deficit is of more than 3% of GDP, and when a country exceeds both thresholds, respectively. Alternatively to these variables constructed according to the Maastricht criteria, we use total *Government Debt* and the *Budget Deficit*, both measured as a share of GDP in percentage points.

The influence of the size of the welfare state on partisan contestation over European integration, i.e., hypothesis 5, is analysed by two variables, *Public Expenditure* and *Inequality*. *Public Expenditure* is total general government expenditure as a share of GDP in percentage points. As we can see in Table 4.2, this variable oscillates between 33.5% and 70.5% of GDP. The lowest value corresponds to Ireland in 2002 and to Lithuania in 2006. The highest value corresponds to Sweden in 1992. *Inequality* is measured by the GINI index and goes from 0, perfect equality, to 100, perfect inequality. Finally, to test hypothesis 6, we use *Growth*, *Unemployment*, and *Inflation*. *Growth* measures the difference between the country's annual real per capita income growth rate and the country's mean growth rate in the period 1980-2010 (with prices indexed 2005). Similarly, *Unemployment* is the difference between the country's annual unemployment rate and the country's mean unemployment rate in the period 1980-2010. *Inflation* measures the difference between the country's annual inflation rate and the country's mean inflation rate in the period 1980-2010.[10]

[10]For Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania,

Table 4.1 summarizes the measurement of the variables and gives detailed information on the sources from where the data is obtained. Table 4.2 gives some details on descriptive statistics. We observe that there is considerable heterogeneity among countries and parties. For example, *Relative Income* varies from 17.400 euros below the EU per capita average to 9.800 euros above. Heteronegeity of partisan support to European integration becomes also very clear from Figure 4.2. We observe that the variation in partisan support is quite different among countries. Furthermore, it also changes considerably in time. As mentioned before, as differences in partisan ideology or competition are unlikely to be responsible for this cross-country cross-time variation, we regard economic factors as a possible explanation for the observed dynamics in partisan support to European integration.

4.4 Results

4.4.1 The determinants of partisan support to European integration

In what follows we briefly comment on model diagnostics to provide support for the adopted estimation approach. Then, we comment in detail on the estimation results regarding the hypotheses raised in Section 4.2. Following the literature, in columns 1 and 2 of Table 4.3 we estimate a model (Model 1) that includes partisan variables with standard OLS panel data regression. Though our sample includes 4 more waves of expert surveys and nearly twice the number of countries, our results in column 1 mainly confirm the findings in Marks et al. (2002). Radical parties are opposed to European integration, while liberal, Christian democratic and social democratic parties widely support European integration. Furthermore, parties in government and with larger electoral support favour European integration. From

Slovakia and Slovenia, to avoid the hiperinflacionary period after the introduction of capitalism in these countries, the period considered is 2000-2010. However, we can see in Table 4.2 that *Inflation* oscillate from -9.34 to 20.29. The former value corresponds to Romania in 2010, when the interanual growth of consumer prices was a 6.09% while its mean growth is 15.43%. The highest value corresponds to Portugal in 1984.

these results we can confirm hypotheses 1 and 2. Following Hellström (2008), in column 2 we have captured family characteristics by a one dimensional ideology variable for which we confirm a quadratic relationship with parties' contestation over European integration. We find that the replacement of partisan family by this ideology variable does not significantly decrease the explanatory content of the model, as the respective R^2 of the models in columns 1 and 2 are almost identical. Therefore, for our further analysis we will use this ideological variable to capture partisan family characteristics. In columns 3 and 4 we display the estimation results from fixed effects panel data regression (Model 2). While the direction and significance of the diagnosed effects is rather similar to those of Model 1 (with the exception of electoral support that becomes insignificant), we find that the existence of fixed effects cannot be rejected with negligible error. Therefore, we regard fixed effects estimation as the appropriate method for our further analysis. Notice also that for the first column of Model 2 with family and country dummies, as displayed in column 1 of Model 1, it turns out that all of these dummy variables are insignificant. This also indicates that neither the family nor the country dummies are indicated to capture unobserved heterogeneity among parties.[11]

Table 4.4 displays the fixed effects estimation results used to contrast the hypothesis of Section 4.2. In column 1 we replicate the results of column 4 in Table 4.3 (Model 2) which, as mentioned before, lead us to confirm hypotheses 1 and 2 in Section 4.2. In columns 2 and 3, we have introduced the second set of variables to test whether economic benefits and costs from EU membership impact on partisan contestation over European integration (Model 3). Regarding hypothesis 3, we find mixed evidence for such an influence. When economic benefits and costs are related to the distance of countries' per capita income from the European mean, we find, indeed, that poorer countries (that should expect higher net benefits) are more favourable towards European integration than richer countries (with probably

[11]Furthermore, once we estimate by fixed effects, most of our categorical variables are omitted because of collinearity, as it is the case with green and regionalist/ethic party family and all country dummies.

lower net benefits). However, direct financial benefits from the EU turn out to have no influence on partisan contestation over European integration. We also find that parties in countries with higher benefits from EMU induced trade are more opposed to EU integration than parties in those countries that benefit less from this trade effect. This is an unexpected result which could have two explanations. First, as EMU induced benefits from trade are indirect benefits that are difficult to quantify, voters and parties might not take them into account when positioning on European integration issues. Second, as this variable is positively correlated to the richness of countries, it somehow reafirms the result regarding relative income, i.e., parties in richer countries are less prone to European integration. Especially, the estimated effects on partisan contestation of relative income is of some importance. For example, the estimate of -0.092 means that the support for European integration from the country with lowest relative income to that with highest relative income grows by 0.666. Overall, from our results we get some weak evidence in favour of hypothesis 3 and conclude that economic costs and benefits have an influence on partisan positioning towards European integration.

With respect to hypothesis 4, we find that parties in countries that either did not fulfill the 3 percent deficit or the 60 percent debt criterium in the Maastricht Treaty after 1992 manifest lower support to European integration by arround 0.26. For parties in countries that violate both criteria simultaneously, we get approximately a similar effect as for parties in countries that do not fulfill a single criterium.[12] Since the control of the fulfillment of the Maastricht criteria used to be rather weak, we use the absolute amount of budget surplus and debt in the estimation in column 3 of Table 4.4 as an alternative measure for the influence of supranational intitutional intervention. We obtain a rather different result as both higher debt and larger surpluses have a negative impact on partisan contestation over European integration. Therefore, we conclude that, at least regarding government debt, hypothesis 4 can be accepted which confirms that parties worry about losing their influence on

[12]Notice, that according to our estimates in Table 4.4 the total effect of a country that does not fulfill both criteria is: -0.255-0.255+0.275=-0.235.

national fiscal policies by the creation of European institutions.

The third set of our hypotheses is contrasted by the estimation results for Model 4, displayed in columns 4 and 5 of Table 4.4. Regarding the influence of larger welfare states, we find that none of our two indicator variables, the Gini index and total public expenditure, has a significant effect on our dependent variable. Therefore, we would reject hypothesis 5. Finally, regarding the impact of the business cycle, we find that parties in countries with higher per capita income growth are more prone to European integration. The same holds for parties in countries with higher unemployment rates. In both cases the effects are of similar size. A 10 percentage point increase in growth or in the unemployment rate yields a 0.5 increase in partisan contestation over European integration. Inflation turns out to have no impact. As the business cycle should be explained best by economic growth, we can take this as an evidence for the influence of the business cycle on partisan support to European integration. Therefore, we would accept hypothesis 6.

Regarding the estimated time effects, we find that support to European integration has significantly grown in the period from 1984 to 1992. In the period from 1992 to 1999 support has been relatively constant, however, at a slightly lower level than in the period after when it has remained almost constant. Notice also, that our estimation results are rather robust as the inclusion of new explanatory variables in Models 3 and 4 does not affect remarkably the estimates of Models 2 and 3, respectively. Summarizing our results, we find evidence, though of different relevance, for all of our hypothesis raised in Section 4.2 except for hypothesis 5.

4.4.2 Time trends in partisan support to European integration

As there have been important institutional changes in the European Union we further study the stability of our estimated model. For this purpose we divide the sample period in two subsample periods. As an important event that could have affected the determinants of partisan contestation on European integration we consider the creation of the EMU in 1999. Consequently, we reexamine Model 4 in Table 4.4 for subsample peridos 1984-1996 (Model 5) and 1999-2010 (Model 6).

Regarding hypothesis 1, our results indicate that partisan characteristics measured by ideology have a similar effect on partisan contestation as in the full sample period, though their importance has diminished over time. On the contrary, in the valuation of hypothesis 2, we observe important changes. For the first subsample period both electoral support and government participation turn out to have a significant influence on partisan positioning on European integration while for the second subsample period both variables have no significant influence. Somehow surprisingly, the impact of electoral support is negative. However, as part of the effect of the size of political parties is already captured by our ideology variable, we cannot conclude from this result that partisan support is decreasing with the size of political parties. The estimated effect of government participation in the first subsample period is even larger than for the full sample. Resuming this, we can conclude that strategic electoral motives for partisan positioning on European integration have lost some of their importance over time.

The second set of our hypotheses refers to the economic dimension of European integration. Regarding hypothesis 3, again, we find divergent results for both subsample periods. While the influence of *Relative Income* becomes significant in the second subsample period, *EU Net Expenditure* becomes insignificant. On the one hand, we get that partisan support to European integration is larger in countries with lower financial benefits from the EU in the first subsample period. On the other hand, we get that partisan support is smaller in countries with higher relative income and larger EMU induced benefits from trade. As all these variables are positively correlated with the richness of countries, as we see in Table 4.7. Overall, we find that while in the first subsample period parties in richer countries are supporters of European integration, in the second subsample period these parties become skepticals on this issue.

Regarding the role of European institutions, analysed by hypothesis 4, we obtain a more complex interaction between levels of government debt and deficit and partisan support to European integration as in Model 4. For the first subsample period we get no significant influence of the Masstricht debt and deficit criteria. This result coincides with anecdotical evidence on that the control of the compliance of the Maastricht criteria were rather relaxed at the beginning and became more strict in the first decade of this century. However, if we consider the absolute levels of government debt and budget surpluses, we find that the former only has a significant (negative) effect in the second subsample period and that the later has a negative impact in the first and a positive impact in the second period. These results indicate that partisan support to European integration declines when national fiscal policies become affected by supranational control. Thus, based on this evidence, now, we would fully accept hypothesis 4 for the second subsample period.

The last set of our hypotheses takes account of the countries' economic situation. While we did not find any effect of the size of welfare states on partisan contestation on European integration in our full sample estimation in Model 4, now it turns out that we obtain a positive relationship between the size of the welfare state and partisan support to European integration for both subsample periods. However, while in the first subsample period partisan support in countries with less inequality is larger, in the second subsample period it is public expenditure that is related to a more favourable contestation on European integration. Thus, with the results from both subsamples we would (weakly) accept hypothesis 5.

With regard to hypothesis 6, we find that only unemployment has a significant influence on partisan contestation on European integration in the first subsample period while for the second subsample period economic growth is the only variable with a significant impact. If we consider that the business cycle should be explained best by economic growth, again, we can take this as an evidence for an increased influence of economic factors in recent periods. Thus, we accept hypothesis 6 for the second period and reject it for the first period.

Taken together, the results on the stability of the relationship between partisan support to European integration and its determinants indicate that economic factors have become of increasing importance. On the one hand, partisan support has declined in countries that have been affected by European control of their fiscal policies. On the other hand, the support to European integration depends on the size of the welfare state and the current economic situation of countries to which the respective parties belong.

4.4.3 Left/right differences in partisan support to European integration

As partisan positions depend strongly on economic stances we could expect that the relationship between partisan support to European integration and its determinants varies across parties. Through Models 7 and 8 we analyse whether this is the case if we distinguish between left-wing and right-wing parties. The estimation results are displayed in Table 4.6. As ideological location of parties has been used as a criterium to form subsamples, here, we refrain from commenting on hypothesis 1. However, the estimation results indicate that the 'ideological support curve' is more concave on the right than on the left partisan spectrum. Regarding hypothesis 2, we find that government participation is relevant only for partisan support to European integration for right-wing parties. Electoral motives play no role for both left and right-wing parties as is the case in Model 4. Overall, the results allow us to be more specific regarding our previous finding in stating that only right-wing parties seem to follow stategic electoral motives when determining their position towards or against European integration.

Our results also highlight partisan differences in the role of economic benefits from the European Union examined with hypothesis 3. These benefits are more relevant in determining partisan support of left-wing parties than that of right-wing parties. Remarkably, we find that the support to European integration of left-wing parties decreases with *Relative Income* and increases with *EU Net Expenditure* in the parties' country. The effect of *Trade Benefits* is similar in both estimations and follows the pattern obtained with Model 4. We conclude that left-wing parties support European integation when it yields (financial) benefits to their countries, which is especially the case for poorer countries. This would led us to accept hypothesis 3 in the case of left-wing parties.

As it turns out, subsampling by our partisan ideology criterium leads to insignificant estimates of non-compliance of Maastricht criteria. This means that it is not a left/right partisan location that determines the relationship between partisan stances on European integration and supranational control of national fiscal policies as indicated by Model 4. On the other hand, if we consider the absolute level of government debt and budget surpluses, we find (significant) negative impacts on partisan support from government debt for left-wing parties and from budget surpluses for right-wing parties. This gives some weak evidence in favour of hypothesis 4 for left-wing parties and means a rejection of this hypthesis for right-wing parties.

With respect to hypothesis 5, we find that support to European integration of left-wing parties is (weakly) higher in countries with a larger welfare state. This result is confirmed with both of our measures, public expenditure and inequality. On the contrary, for right-wing parties we obtain a negative impact of public expenditure on the support to European integration. Thus, hypothesis 5 would be accepted with somehow weak evidence for left-wing parties and rejected in case of right-wing parties.

Finally, regarding the influence of the business cycle on partisan stances to European integration, we find a positive (significant) effect of economic growth, unemployment and inflation for left-wing parties while for right-wing parties only unemployment shows to have a positive (significant) influence. Again, if we consider that the business cycle is explained best by economic growth, our results would yield us to accept hypothesis 6 for left-wing parties while for right-wing parties we would reject it.

Summing up, we find important differences in the relationship between partisan support to European integration and its determinants among left and right-wing parties. When comparing the results of models 7 and 8 to those of model 4, we find that evidence in favour of hypotheses 3 and 5 is growing in the case of left-wing parties while evidence for hypothesis 6 is decreasing in the case of right-wing parties. On the contrary, evidence for hypothesis 4 is decreasing in both models based on ideologically grouped subsamples. This indicates that economic motives, in general, are more relevant for left-wing parties to determine their support to European integration than for right-wing parties.

4.5 Conclusions

What determines the European integration process has been analysed in the literature exclusively from a partisan perspective. In this chapter we study whether economic factors influence partisan support to European integration. We find that, indeed, partisan contestation over European integration is affected by several economic variables. First, partisan support is larger in relatively poorer countries indicating that economic benefits from EU membership seem to play an important role. Second, in countries that were affected by the Masstricht criteria partisan support to European integration decreases significantly. We take this as evidence that parties are rather jealous to loose some of their influence on fiscal policies to supranational organizations and therefore reduce their support when this becomes effective. Third, we find weak evidence for a larger partisan support in countries with more developed welfare states. Fourth, we detect that support to European integration is in parallel to the business cycle. Finally, our results indicate that the importance of economic factors has grown in recent periods and that these factors are of more importance for left-wing parties in determining their support to European integration.

From our results we obtain some interesting policy implications for the future of the

European integration process in particular and for processes of economic integration in general. First, as partisan support to European integration depends on economic factors, future advances in the European integration process will depend crutially on the existence of economic benefits and their distribution among EU member countries to reach Pareto supperior allocations. Second, as it is impossible to obtain positive direct monetary benefits for all members by further integration policies, it becomes particulary important to accentuate the indirect benefits of such policies. For example, from our results we find that partisan support in those countries with largest benefits from EMU induced trade is lower than in those countries with smaller benefits. We take this as evidence for the lack of awareness of these indirect benefits to the general public. Finally, while the European integration process unquestionably has its historic specificities which lay in the experiences in and after World War II, it seems that this process after the substancial advances that have been reached, now has come to a 'normal' state of affairs which also allows to derive lessons for other processes of economic integration. Therefore, for these processes the first two policy implications are aplicable too.

4.6 Appendix

4.6.1 Data Processing

Partisan data for 2010 is not complete because the data was extracted before the Chapel Hill Experts Survey data set was completly finished. We have used information about partisan positioning on European issues and partisan 'overall' ideology. Information on partisan family is not in the data. We have assumed that parties belong to the same family as in the previous survey. Parties' *Electoral Support* and *Government Participation* for 2010 is from our own evaluations. Similarly, there is missing data about parties' ideology in some survey years. We assumed that their ideology is equal to their ideology quote in the closest survey year. Because of missing information, 28 observations on parties were not included in our sample.

There is no information on the Gini index for all years to report *Inequality*. In order to avoid losing more observations, we estimate missing data by taking the average of the two closest observations in time.

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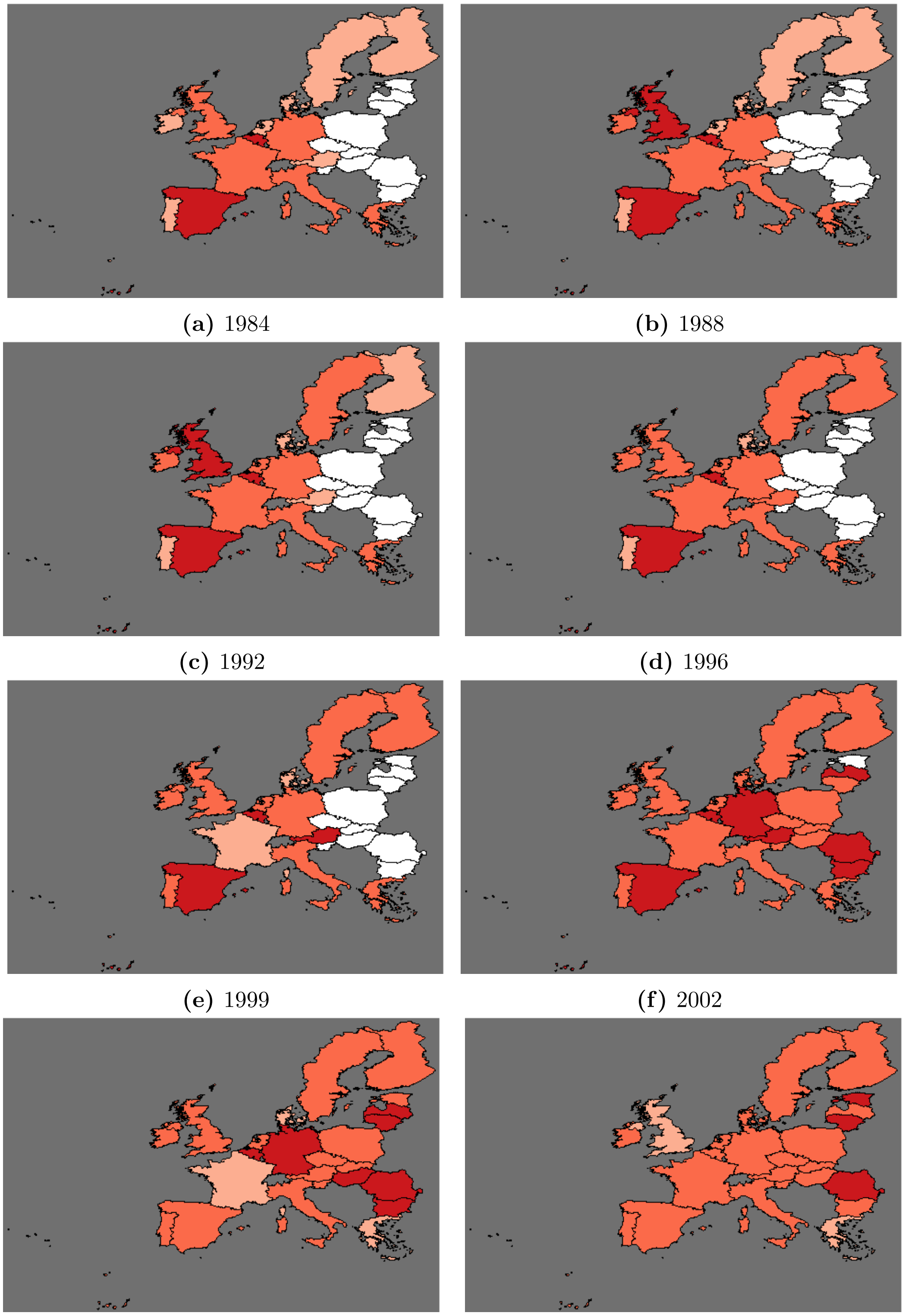


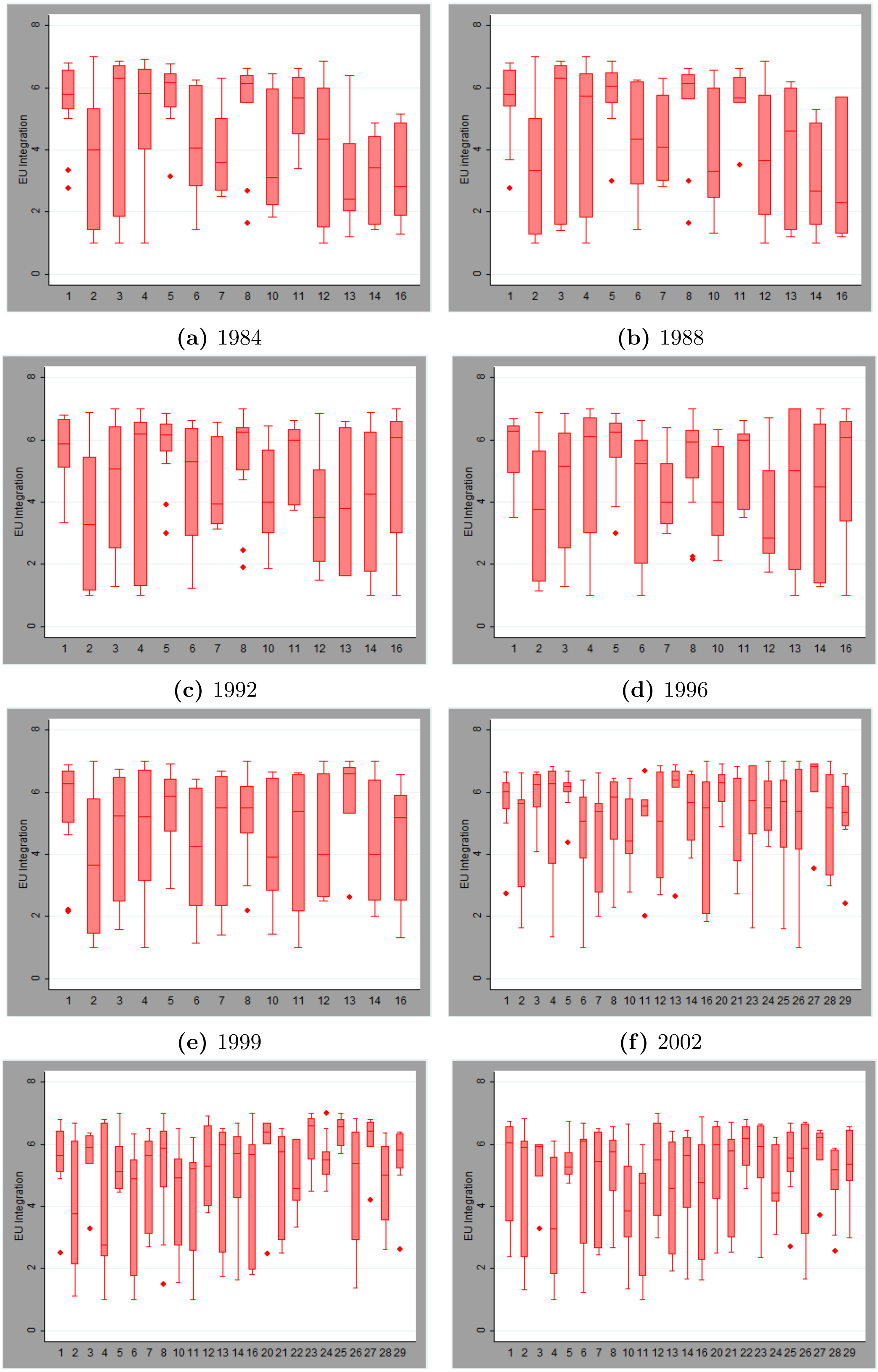
(a) 1984 **(b)** 1988

(c) 1992 **(d)** 1996

(e) 1999 **(f)** 2002

(g) 2006 **(h)** 2010

Figure 4.1: Mean partisan positions towards European integration by country and year. White colour means that there is no information for that country. The intensity of the red colour corresponds to the following intervals: [1, 2.5], (2.5, 4], (4, 5.5], (5.5, 7].



(a) 1984 (b) 1988

(c) 1992 (d) 1996

(e) 1999 (f) 2002

(g) 2006 (h) 2010

Figure 4.2: Distribution of partisan positions towards European integration by country and year. Numbers correspond to countries as follows: Belgium (1), Denmark (2), Germany (3), Greece (4), Spain (5), France (6), Ireland (7), Italy (8), the Netherlands (10), UK (11), Portugal (12), Austria (13), Finland (14), Swedem (16), Bulgaria (20), Czech Republic (21), Estonia (22), Hungary (23), Latvia (24), Lithuania (25), Poland (26), Romania (27), Slovakia (28) and Slovenia (29).

Variable	**Measurement**	**Source**
European integration	Parties' position towards European integration from 1 (strongly opposed) to 7 (strongly in favour).	Bakker et al. (2012) and Ray (1999)
Ideology	Parties' ideological position from 0 (extreme left) to 10 (extreme right).	Bakker et al. (2012) and Ray (1999)
Electoral Support	Parties' share of total votes in the last national government elections before the survey year in percentage points.	Bakker et al. (2012) and Ray (1999)
Government Participation	Dichotomous variable for parties in government (1 = in government)	Bakker et al. (2012) and Ray (1999)
Relative Income	Difference between country real per capita income and EU mean real per capita income in thousands of euros PPP.	Own calculation with data from Eurostat (2013a) and WDB (2013). Conversion of data in dollars from WDB (2013) into euros by Fxtop (2013)
EU Net Expenditure	EU expenditure in the country minus national contributions to the EU budget as a share of GDP in percentage points.	Own calculation with data from European Comission (2009) and European Comission (2013)
Trade Benefits	Benefits from EMU membership induced trade as a share of GDP in percentge points.	Own calculation with data from Eurostat (2013b)
Maastricht debt non-compliance	Dichotomous variable for countries with a government debt of more than 60% of GDP (1 = non-compliance).	Own calculation with data from International Monetary Fund (2010)
Maastricht deficit non-compliance	Dichotomous variable for countries with a government deficit of more than 3% of GDP (1 = non-compliance).	Own calculation with data from OECD (2012) and Eurostat (2012)
Maastricht debt and deficit non-compliance	Dichotomous variable for countries with both a government debt and deficit of more than 60% and 3% of GDP, respectively.	Own calculation with data from International Monetary Fund (2010), OECD (2012) and Eurostat (2012)
Government Debt	Government debt as a share of GDP in percentage points.	International Monetary Fund (2010)
Budget Surplus	Government surplus as a share of GDP in percentage points.	OECD (2012) and Eurostat (2012)
Public Expenditure	Total general government expenditure as a share of GDP in percentage points.	OECD (2013a) and Eurostat (2012)
Inequality	GINI index from 0 (perfect equality) to 100 (perfect inequality).	UNU-WIDER (2013)
Growth	Difference between the country's annual per capita income growth rate and the country's mean growth rate in the period 1980-2010 (base year for real per capita income 2005).	Own calculation with data from OECD (2013a) and WDB (2013)
Unemployment	Difference between the country's annual unemployment rate and the country's mean unemployment rate in the period 1980-2010.	Own calculation with data from WDB (2012b)
Inflation	Difference between the country's annual inflation rate and the country's mean inflation rate in the period 1980-2010 (2000-2010 for Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia).	Own calculation with data from WDB (2012a)

Table 4.1: Data definitions and sources. The measurment of variables refers to the respective survey year if not indicated otherwise.

Variable	**Mean**	**Std. Dev.**	**Min**	**Max**
European Integration	4.82	1.81	1	7
Ideology	4.96	2.36	0	10
Electoral Support	11.06	12.24	0	52.73
Government Participation	0.28	0.44	0	1
Relative Income	-1.71	5.53	-17.40	9.80
EU Net Expenditure	0.60	1.38	-4.14	6.66
Trade benefits	0.41	1.80	-10.50	7.80
Maastricht Debt non-compliance	0.38	0.49	0	1
Maastricht Deficit non-compliance	0.41	0.49	0	1
Maastricht Debt and Deficit non-compliance	0.22	0.41	0	1
Government Debt	62.24	29.36	4.41	144.55
Budget surplus	-3.51	3.62	-13.30	5.20
Public Expenditure	47.95	7.39	33.50	70.50
Inequality	29.13	4.67	20.00	39.00
Growth	0.87	2.36	-6.09	10.82
Unemployment	0.42	2.77	-7.74	8.63
Inflation	-1.07	3.31	-9.34	20.29

Table 4.2: Descriptive statistics.

	Model 1		**Model 2**	
	OLS		**Fixed Effects**	
Radical Right	-1.858***		-0.192	
	(0.247)		(0.524)	
Conservatives	0.609**		-0.629	
	(0.238)		(0.626)	
Liberal	1.715***		-0.714	
	(0.228)		(0.520)	
Christian-Democratic	1.434***		-0.125	
	(0.250)		(0.745)	
Socialist	1.135***		-0.388	
	(0.232)		(1.004)	
Radical Left	-1.441***		-0.599	
	(0.233)		(1.164)	
Green	0.070		-	
	(0.241)			
Regionalist/Ethnic	0.644***		-	
	(0.247)			
No Family	-0.168		-0.960	
	(0.263)		(0.819)	
Confessional	-0.540*		-1.789**	
	(0.284)		(0.835)	
Ideology		1.844***		0.685***
		(0.068)		(0.126)
Ideology Squared		-0.178***		-0.065***
		(0.007)		(0.011)
Electoral Support	0.013***	0.020***	-0.003	-0.003
	(0.004)	(0.003)	(0.006)	(0.006)
Government Participation	0.282***	0.407***	0.183***	0.158**
	(0.095)	(0.093)	(0.067)	(0.067)
1984	-0.293*	-0.107	-0.408***	-0.404***
	(0.150)	(0.149)	(0.094)	(0.094)
1988	-0.230	0.002	-0.278***	-0.280***
	(0.148)	(0.148)	(0.092)	(0.094)
1992	0.014	0.302**	-0.040	-0.020
	(0.147)	(0.147)	(0.092)	(0.093)
1996	0.005	0.251*	-0.035	-0.032
	(0.146)	(0.144)	(0.090)	(0.091)
1999	-0.011	-0.126	-0.051	-0.122
	(0.146)	(0.142)	(0.092)	(0.092)
2002	0.147	0.157	0.030	0.006
	(0.135)	(0.129)	(0.084)	(0.084)
2006	-0.020	0.052	-0.029	-0.027
	(0.132)	(0.127)	(0.080)	(0.080)
Constant	4.298***	0.834***	5.340***	3.554***
	(0.293)	(0.232)	(0.461)	(0.348)
N	1192	1164	1192	1164
Adj R-squared / R-squared within	0.566	0.543	0.064	0.086
F test that all $u_i = 0$:	-	-	8.51	8.15

Table 4.3: Panel regression. Standard errors are in parentheses. *,**,*** indicate significance at the 10, 5 and 1 percent level, respectively. The base categorial variables for party family, country and year are *Agrarian*, *Germany* and *2010*, respectively. Country dummies with a significant positive effect in both models are Belgium, Spain and Italy, and with a significant negative effect Denmark, Ireland and Finand. The largest effects in Model 1 are for Finland, with a coefficient of -1.24, and Spain, with a coefficient of 0.86. The detailed results are available upon request from the authors.

	Model 2 H1-H2	**Model 3 H1-H4**		**Model 4 H1-H6**	
Ideology	0.685***	0.735***	0.714***	0.732***	0.732***
	(0.126)	(0.125)	(0.123)	(0.123)	(0.122)
Ideology Squared	-0.065***	-0.069***	-0.069***	-0.072***	-0.072***
	(0.011)	(0.011)	(0.011)	(0.011)	(0.011)
Electoral Support	-0.003	-0.004	-0.004	-0.004	-0.004
	(0.006)	(0.006)	(0.006)	(0.006)	(0.005)
Government Participation	0.158**	0.127*	0.132**	0.140**	0.136**
	(0.067)	(0.066)	(0.066)	(0.065)	(0.065)
Relative Income		-0.092***	-0.080***	-0.029	-0.040*
		(0.019)	(0.021)	(0.023)	(0.023)
EU Net Expenditure		0.014	0.024	0.042	0.038
		(0.032)	(0.032)	(0.033)	(0.033)
Trade Benefits		-0.065***	-0.061***	-0.058***	-0.061***
		(0.018)	(0.017)	(0.018)	(0.018)
Maastricht Debt Non-Compliance		-0.255***		-0.240***	
		(0.093)		(0.092)	
Maastricht Deficit Non-Compliance		-0.255**		-0.148	
		(0.104)		(0.109)	
Maastricht Debt and Deficit Non-Compliance		0.275**		0.211*	
		(0.116)		(0.116)	
Government Debt			-0.006***		-0.007***
			(0.002)		(0.003)
Budget Surplus			-0.047***		-0.032**
			(0.012)		(0.015)
Public Expenditure				0.004	0.001
				(0.009)	(0.012)
Inequality				-0.012	-0.016
				(0.010)	(0.010)
Growth				0.052***	0.056***
				(0.015)	(0.015)
Unemployment				0.063***	0.061***
				(0.012)	(0.012)
Inflation				0.024**	0.018
				(0.011)	(0.011)
1984	-0.404***	-1.128***	-0.898***	-1.106***	-1.061***
	(0.094)	(0.175)	(0.158)	(0.192)	(0.180)
1988	-0.280***	-0.939***	-0.573***	-0.864***	-0.737***
	(0.094)	(0.166)	(0.146)	(0.174)	(0.160)
1992	-0.020	-0.461***	-0.400***	-0.316**	-0.347**
	(0.093)	(0.127)	(0.133)	(0.136)	(0.139)
1996	-0.032	-0.428***	-0.252**	-0.412***	-0.356***
	(0.091)	(0.120)	(0.128)	(0.126)	(0.130)
1999	-0.122	-0.562***	-0.201	-0.385**	-0.282*
	(0.092)	(0.142)	(0.145)	(0.152)	(0.150)
2002	0.006	-0.361***	-0.061	-0.079	0.010
	(0.084)	(0.126)	(0.129)	(0.136)	(0.129)
2006	-0.027	-0.182*	0.151	-0.027	0.092
	(0.080)	(0.104)	(0.112)	(0.112)	(0.119)
Constant	3.554***	3.825***	3.773***	3.959***	4.363***
	(0.348)	(0.353)	(0.377)	(0.640)	(0.675)
N	1164	1164	1164	1164	1164
R-squared within	0.086	0.123	0.133	0.163	0.170
F test that all $u_i = 0$:	10.25	10.17	9.98	10.30	9.95

Table 4.4: Fixed effects regression. Standard errors are in parentheses. *,**,*** indicate significance at the 10, 5 and 1 percent level, respectively. The base categorial variables are *Germany* (country) and *2010* (year).

	Model 5		**Model 6**	
	1984-1996		**1999-2010**	
Ideology	1.029***	1.043***	0.708***	0.665***
	(0.296)	(0.296)	(0.144)	(0.143)
Ideology Squared	-0.103***	-0.104***	-0.062***	-0.059***
	(0.027)	(0.027)	(0.012)	(0.012)
Electoral Support	-0.020**	-0.021**	-0.000	0.001
	(0.010)	(0.010)	(0.005)	(0.005)
Government Participation	0.268***	0.255**	0.063	0.082
	(0.100)	(0.100)	(0.063)	(0.062)
Relative Income	-0.003	0.021	-0.085***	-0.114***
	(0.050)	(0.047)	(0.032)	(0.029)
EU Net Expenditure	-0.132*	-0.137**	0.045	0.017
	(0.070)	(0.069)	(0.037)	(0.036)
Trade Benefits	-	-	-0.056***	-0.053***
			(0.014)	(0.014)
Maastricht Debt Non-Compliance	0.169		-0.214**	
	(0.250)		(0.091)	
Maastricht Deficit Non-Compliance	0.008		-0.139	
	(0.235)		(0.103)	
Maastricht Debt and Deficit Non-Compliance	-0.001		0.274**	
	(0.269)		(0.120)	
Government Debt		-0.001		-0.010***
		(0.005)		(0.003)
Budget Surplus		-0.037*		0.047***
		(0.021)		(0.018)
Public Expenditure	0.006	-0.013	0.011	0.039***
	(0.015)	(0.016)	(0.011)	(0.014)
Inequality	-0.024*	-0.024*	-0.002	0.003
	(0.013)	(0.013)	(0.015)	(0.015)
Growth	0.004	-0.008	0.043***	0.053***
	(0.026)	(0.025)	(0.016)	(0.016)
Unemployment	0.102***	0.097***	0.008	0.011
	(0.024)	(0.025)	(0.011)	(0.011)
Inflation	-0.007	-0.015	-0.006	0.002
	(0.019)	(0.019)	(0.013)	(0.013)
1984	-0.158	-0.301*		
	(0.240)	(0.172)		
1988	0.024	-0.094		
	(0.232)	(0.122)		
1992	0.183*	0.108		
	(0.103)	(0.109)		
1999			-0.459***	-0.809***
			(0.174)	(0.160)
2002			-0.214	-0.508***
			(0.154)	(0.143)
2006			-0.125	-0.447***
			(0.101)	(0.120)
Constant	3.218***	4.190***	2.877***	2.377***
	(1.209)	(1.182)	(0.691)	(0.724)
N	491	491	673	673
R-squared within	0.269	0.272	0.161	0.176
F test that all $u_i = 0$:	14.82	13.21	13.15	13.53

Table 4.5: Fixed effects regression for subsamples: 1984-1996 and 1999-2010. Standard errors are in parentheses. *,**,*** indicate significance at the 10, 5 and 1 percent level, respectively. The base categorial variables are *1996* for the the first subsample period and *2010* for the last subsample period.

	Model 7		**Model 8**	
	Left-wing parties		**Right-wing parties**	
Ideology	0.363	0.286	2.417***	2.475***
	(0.270)	(0.268)	(0.513)	(0.501)
Ideology Squared	-0.016	-0.002	-0.190***	-0.195***
	(0.045)	(0.044)	(0.036)	(0.035)
Electoral Support	0.009	0.008	-0.007	-0.005
	(0.010)	(0.010)	(0.007)	(0.007)
Government Participation	-0.003	-0.001	0.167**	0.148*
	(0.120)	(0.118)	(0.084)	(0.083)
Relative Income	-0.036	-0.059*	-0.030	-0.042
	(0.034)	(0.035)	(0.031)	(0.031)
EU Net Expenditure	0.104**	0.093**	-0.011	-0.003
	(0.047)	(0.047)	(0.050)	(0.049)
Trade Benefits	-0.056**	-0.052*	-0.071***	-0.075***
	(0.027)	(0.027)	(0.024)	(0.023)
Maastricht Debt Non-Compliance	-0.208		-0.174	
	(0.139)		(0.124)	
Maastricht Deficit Non-Compliance	-0.114		-0.149	
	(0.163)		(0.151)	
Maastricht Debt and Deficit Non-Compliance	0.171		0.132	
	(0.178)		(0.156)	
Government Debt		-0.011***		-0.005
		(0.004)		(0.004)
Budget Surplus		0.005		-0.073***
		(0.022)		(0.021)
Public Expenditure	0.010	0.031*	-0.001	-0.026*
	(0.013)	(0.018)	(0.012)	(0.016)
Inequality	-0.022	-0.026*	0.004	0.002
	(0.015)	(0.015)	(0.014)	(0.014)
Growth	0.083***	0.095***	0.032	0.028
	(0.024)	(0.024)	(0.020)	(0.020)
Unemployment	0.056***	0.061***	0.073***	0.063***
	(0.018)	(0.018)	(0.016)	(0.016)
Inflation	0.044**	0.045**	0.024	0.016
	(0.018)	(0.019)	(0.015)	(0.015)
1984	-1.711***	-1.903***	-0.722***	-0.574**
	(0.303)	(0.293)	(0.254)	(0.231)
1988	-1.391***	-1.496***	-0.465**	-0.185
	(0.273)	(0.258)	(0.230)	(0.208)
1992	-0.742***	-0.921***	-0.025	0.025
	(0.210)	(0.220)	(0.182)	(0.182)
1996	-0.711***	-0.787***	-0.250	-0.088
	(0.196)	(0.203)	(0.172)	(0.174)
1999	-0.548**	-0.633***	-0.324	-0.027
	(0.241)	(0.238)	(0.204)	(0.198)
2002	-0.183	-0.257	-0.004	0.219
	(0.213)	(0.205)	(0.184)	(0.170)
2006	-0.212	-0.296	0.063	0.370**
	(0.176)	(0.188)	(0.149)	(0.157)
Constant	4.438***	4.406***	-2.049	-1.192
	(0.934)	(0.997)	(2.028)	(1.997)
N	565	565	583	583
R-squared within	0.2013	0.214	0.232	0.257
F test that all $u_i = 0$:	7.27	6.69	11.12	11.51

Table 4.6: Fixed effects regression analysis of *European Integration* for subsamples: left-wing parties and right-wing parties. Standard errors are in parentheses. *,**,*** indicate significance at the 10, 5 and 1 percent level, respectively. The base category for year is *2010*.

		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
1	*European Integration*	1.0000							
2	*Ideology*	0.1105	1.0000						
3	*Electoral Support*	0.2979	0.1086	1.0000					
4	*Government Participation*	0.3146	0.1406	0.4321	1.0000				
5	*Relative Income*	-0.1416	-0.0285	-0.0492	0.0073	1.0000			
6	*EU Net Expenditure*	0.0385	-0.0779	0.0940	-0.0385	-0.4998	1.0000		
7	*Trade Benefits*	0.0425	0.0317	-0.0237	0.0286	0.1123	-0.0146	1.0000	
8	*Maastricht Debt Non-Compliance*	0.0338	-0.0149	-0.0439	-0.0269	0.3218	-0.0736	0.1835	1.0000
9	*Maastricht Deficit Non-Compliance*	0.0602	0.0182	0.0233	-0.0188	-0.1070	0.0734	-0.0179	0.2432
10	*Maastricht Debt and Deficit Non-Compliance*	0.0611	-0.0253	0.0122	-0.0124	0.1730	-0.0319	0.0268	0.6475
11	*Government Debt*	0.0366	-0.0299	-0.0783	-0.0132	0.3898	-0.0998	0.0884	0.6635
12	*Budget Surplus*	-0.0815	0.0260	-0.0112	0.0191	0.1082	-0.0966	0.1138	-0.1322
13	*Public Expenditure*	-0.1493	0.0363	-0.0537	0.0189	0.5775	-0.4291	-0.0272	0.2853
14	*Inequality*	0.1257	-0.0616	0.0504	-0.0402	-0.4481	0.4634	-0.0912	0.0674
15	*Growth*	0.0448	0.0135	-0.0085	0.0413	-0.3414	0.1294	0.0062	-0.2273
16	*Unemployment*	0.0309	-0.0211	-0.0346	-0.0548	-0.1629	0.1290	-0.1479	0.0674
17	*Inflation*	-0.0367	-0.0201	0.0016	0.0004	0.0141	-0.0330	-0.0090	-0.3009

		9	**10**	**11**	**12**	**13**	**14**	**15**	**16**
7	*Trade Benefits*								
8	*Maastricht Debt Non-Compliance*								
9	*Maastricht Deficit Non-Compliance*	1.0000							
10	*Maastricht Debt and Deficit Non-Compliance*	0.6417	1.0000						
11	*Government Debt*	0.2141	0.5296	1.0000					
12	*Budget Surplus*	-0.5429	-0.4268	-0.3778	1.0000				
13	*Public Expenditure*	0.1800	0.2509	0.4705	-0.2483	1.0000			
14	*Inequality*	0.1555	0.1688	0.0481	-0.2229	-0.5350	1.0000		
15	*Growth*	-0.3820	-0.2741	-0.2839	0.2755	-0.4238	0.0934	1.0000	
16	*Unemployment*	0.2268	0.1230	0.1860	-0.4225	0.2801	0.0133	-0.2317	1.0000
17	*Inflation*	-0.2849	-0.2253	-0.2055	-0.0501	-0.0391	-0.1556	-0.0058	-0.0624

Table 4.7: Correlation matrix.