STOCKHOLM SCHOOL OF ECONOMICS
Department of Economics
659: Degree Project in Economics
Spring 2015

Participation in a coup d'état: an alternative approach to the classic revolutionary setting

Benjamin Dousa (22823) and Anton Vedin (22829)

Abstract: Using a game-theoretic framework, we investigate an oppositional player's decision about participating or abstaining from participation in a coup d'état. In our model, players use the information on the regime's breaking point, the cost of participation, the cost of abstaining from a successful coup, and the size of the opposition to decide when to participate. We find that the decision depends on the player's impact on the outcome of the coup. If a player believes that he will be pivotal to the outcome or that enough other players are participating to reach the regime's breaking point, he will always prefer to participate. On the other hand, he will prefer to abstain if he believes that he will not be pivotal and that the other participants are not enough to reach the breaking point.

Keywords: Revolution, coup d'état
JEL: C72, D74

Supervisor:	Karl Wärneryd
Date submitted:	18 May 2015
Date examined:	4 June 2015
Discussants:	Samuel Förnes & Tingting Ferrari
Examiner:	Anders Olofsgård

The authors would appreciatively like to acknowledge the support and guidance from our supervisor, associate professor Karl Wärneryd at the Department of Economics at the Stockholm School of Economics. We would also like to declare gratitude to our respective families for their unconditional support in good times and in bad.

Table of Content

1 INTRODUCTION 4

2 BACKGROUND AND THE CURRENT STATE OF KNOWLEDGE 6

3 RESEARCH QUESTION 10

4 SETUP OF THE MODEL 11

5 SOLVING THE MODEL 13

6 EXTENDED THOUGHTS AND VARIATIONS 24

7 CONCLUSION 27

8 BIBLIOGRAPHY 28

1 Introduction

Demonstrations. Violence. War.

Overthrowing a government and replacing it with a new one is seldom experienced without aggression. We are currently witnessing a new wave of leaders falling and new ones coming to power. In the spirit of public choice, leaders and opposition will do what it takes to gain power, stay in power, and withhold others from it.

When taking a closer look at the world of revolutions, we have come to question if they really are such grassroots movements as the media makes them out to be. Romanticisation of the past is not a new phenomenon. Gordon Tullock (2005, p. 163) writes that:

> "The standard view of revolutions is extremely romantic in nature. Formal and large-scale use of violence is an important element in almost all romantic literature. /…/ This has led to vast misunderstandings of the subject and, in essence, to the definition of the word "revolution" in such a way that it refers to something which almost never happens. The standard concept of the revolution is that a group of poor, oppressed people rise against their oppressors."

Forcing down a leader in a country requires resources and information at a level not seen in the households of common people. Still, revolutions do occur, which leads us to believe that there are other forces at play.

Changing the setting to coups d'état rather than popular uprisings, players may or may not act differently. Rational self-preserving individuals will in a context of grassroots revolutions, or voting for that matter, contribute only if they believe that they will be pivotal. This is due to the insight that the public good would be provided anyway if they do not participate and enough others do. Belonging to an elite obviously includes benefits: monetary and/or social, but also includes demands. An elite, which challenges the power, depends on others in the same elite to participate as well. This can be seen in wings in political parties, aristocrats in a feudal society and even armed conflicts today.

If an elite is seen as smaller in absolute numbers than a grassroots movement, it is also easier to evaluate whether a member of the elite really has participated or not. Anonymity is removed. If you were in support of an opposition, planning a coup against current leadership, would you not inflict a post-attempt cost on your fellow members that did not participate, if you came to power? Are they really your friends?

Unus pro omnibus, omnes pro uno.

One for all, all for one. The currency of loyalty is only trustworthy as long as users find it so. Since being part of an elite itself has some monetary and/or social benefits, the others in your elite, gang or party may remove these. In practice, this may be

suspension of deserters from the elite or even death. Assuming this radically changes the world of revolutions.

In this thesis, we extend the game-theoretic model on public good provision developed by Palfrey & Rosenthal (1984) to apply it to a coup d'état setting. This is achieved by decreasing the size of the population, thus removing the assumption of anonymity from the original model. This allows for full control of the population, which means that players can punish those that abstain from participation. We believe that this is more appropriate and realistic in a coup d'état setting.

The text is organised as follows. Section 2 provides an overview of the current state of knowledge both concerning revolutions in general and coups d'état in particular. We also provide a description of Palfrey & Rosenthal's famous model of the provision of a public good, which we use as a foundation for our set up. In section 3, we present our research problem and our research questions. In section 4, we develop our model of a coup setting, which we then solve using a numerical example in section 5. Section 6 provides some extended thoughts and variations on our assumptions and variables. Section 7 serves as a conclusion where we sum up our findings and provide an answer to our research question. Finally, our bibliography can be found in section 8.

2 Background and the Current State of Knowledge

Whether events are revolutions, rebellions, revolts, uprisings or coups d'état has been a heavily debated subject by academics, foremost historians. Scholars have come up with several definitions and different criteria for separating these from one another. These could be based on participants, objectives, socio-economic background and other factors (Kramnick, 1972, p. 26). What the definitions have in common is that they all include some type of change: social, economic, and/or political. The debate concerns the proportion of the change, the regime being exposed, and usage of violence. Definitions can be either wide or narrow, where a more narrow view emphasises violence to reach change while a wider definition only concerns the change or restructuring of government and/or society (Stone, 1966).

In the Oxford Dictionary, a revolution is defined as "a forcible overthrow of a government or social order, in favour of a new system". This provides us with a broad definition, including all or most of the abovementioned events. It also implies two preconditions – a hostile takeover of the ruling regime and a new state following the revolution.

Following Luttwack (1969), cited in Sutter (2000, p. 205), we define a coup d'état as "the infiltration of a small but critical segment of the state apparatus, which is then used to displace the government from its control of the remainder". Using this definition indicates there are already some benefits being a part of an elite such as salary and power.

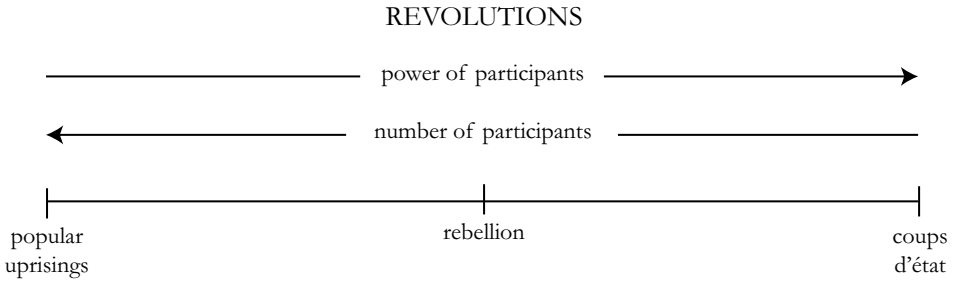


Figure 1: Spectrum of Revolutions

It is often assumed, and fairly so, that the post-revolution stage is a public good. A public good, as we know is both non-rival and non-excludable, which entails that all individuals will be able to enjoy the benefits of the post-revolution stage whether they participate or not. When combining this with the fact that participation in a revolution is costly (in terms of time, possible violence, or even death), we end up with a free-rider problem, termed the "Rebel's Dilemma" by Lichbach (1994, p. 387). This phenomenon has interested researchers for quite some time and has resulted in various theories and models offering solutions to the problem.

Lohmann (2000) develops a dynamic model of continuous information, called informational cascade, to solve the free-rider problem. She assigns individuals into groups based on their incentives and motivation for acting or abstaining should there be a collective action to overthrow the status quo. The individuals that will always participate are assigned to the "extremist" group, those that prefer the status quo and will always abstain are assigned to the "status quo supporter" group, and those that are indifferent between the status quo and the potential post-revolution stage are assigned to "apathetic moderates". Finally, the group of interest is that which consists of individuals making their decision based on what they observe in previous periods is known as the "activist moderates". She argues that individuals in this group can affect the outcome in two ways.

First, they may actually be the pivotal individual triggering the break of the status quo. Second, they may participate to "be counted" in order to send information to other individuals about the number of participants. This, she argues, is due to the fact that their incentives and motivation differs from that of the extremists. Assuming full information and anonymity, she then concludes that this micro-level activity has implications on the meso-level, as "this information changes [people's] incentives to act or abstain in the future". At the macro-level, the outcome of the collective action is determined by the difference between the expected number of turnouts and the actual number of turnouts.

The model in Lohmann (2000) is mostly based on her previous work, starting with Lohmann (1993), and has been used by her to explain the turnout of the Monday Demonstrations in Leipzig in 1989-91 (Lohmann, 1994). This is, however, the only example she puts forward and, as far as we are concerned, the only example ever explained using the informational cascade set-up. It can even be argued that the Monday Demonstrations in fact was not the cause of the fall of communism in East Germany, but that it actually was the weakened Soviet Union that caused the fall.

Taking one step away from the classical view of revolutions, vanguards can trigger and therefore mobilise a greater proportion of the population (Bueno De Mesquita, 2010). This view can be used to illustrate how groups in opposition to the status quo may have an impact on society as a whole. We argue that widening and making the view a bit more generous could include an elite to be such a vanguard. Even though the vanguard is a small proportion of the entire country's population in both absolute and relative numbers, they can successfully push for a regime change.

The framework that we will be basing our model on originates with Palfrey & Rosenthal (1983), and their model of voter turnout. They developed the model as an attempt to give a game theoretic answer to the question of why voters vote, even though the probability of a single voter being the decisive voter (in large elections, that is) is rather miniscule. Voting is also associated with a cost (transport, time etc.), which means that each voter must weigh the benefit of voting against the cost. They showed that "equilibria exist with substantial turnout even when both the majority is much larger than the minority and the costs of voting are exceptionally high".

The framework was later generalised (Palfrey & Rosenthal, 1984) to consider all situations in which a discrete public good was to be provided (such as the outcome of an election). Once again the focus was on overcoming the free-rider problem associated with such situations. They propose a game with M players i either contributing or not contributing to the provision of the public good. Essentially, the good will be provided if the number of participants, m, exceeds the necessary number of contributors, w. As in the voting case described above, they also assume that there is a cost, c, associated with contributing and that each player will only contribute if they believe they will be pivotal. They conclude that there are multiple equilibria and that, because of this, some form of coordination is very important in order to achieve a Nash equilibrium.

Olsson-Yaouzis (2010) uses Palfrey & Rosenthal's model from 1984, puts it in a revolutionary setting and includes one more variable in the model, t, which is the government's threshold for punishment. This is either the government's ability to act or its willingness in terms of an intervention policy. We will not be using this variable t as we will be assuming costs inflicted by both the rulers on revolutionaries and no-show costs inflicted by the rest of the opposition on abstainers to be included in the exogenous costs.

What all above-mentioned authors have in common is the assumption that most revolutions are commonly found in the popular rising part of the spectrum of revolutions. However, taking a closer look at revolutions such as Egypt (2013), Thailand (2006), Burma (1988), Greece (1973), Dahomey (1963) and anti-western demonstrations in the Middle East during the 50s through to the early 70s rather indicate a setting where elites capitalise on popular risings. Protests send a public signal, which helps elites coordinate a coup d'état (Casper & Tyson, 2014). We will develop this thought even further and experiment whether the regime's breaking point, w, is actually a combination of several variables in some function. Getting signals from the public as in popular risings, decreases the information asymmetry, thus making coordination easier.

As the quote by Gordon Tullock in the introduction implies, most revolutions are carried out by elites rather than by common people. Tullock (2005, p. 273) also states that three out of four successful revolutions have been in coup format where usually a high-ranked military leader aspires for more power.

Looking at empirical studies, we observe that 51 percent of all coup attempts are successful and there seems to be three main factors that reflect the underlying risk of a coup attempt: the strength of the civil society, regime legitimacy and past history of coups (Belkin & Schofer, 2003). As everyone can observe these factors, we will assume that information about the regime's breaking point is known and open to everyone. However, other assumptions could be made which changes the set up of the model. For instance a set up where the players, citizens, have imperfect information about the regime's ability to defend itself (Edmond, 2013). These

models are typically called global games where players may send signals about their private information.

Our setting will be constructed in a fashion where every member of the opposing elite will be a player in the game. We prefer this set up to Sutter's (2000) set up, where he considers an entire elite or coup leader as a single player, as it allows us to study the participation of elite members.

3 Research Question

Looking back at previous regime changes in non-democracies, we have reason to believe a coup d'état setting is preferable to a popular uprising setting, and it is our aim to explore how players act in this environment. More specifically, we want to investigate the level of participation.

Our approach is to use a game-theoretic structure with Palfrey & Rosenthal's (1984) model as a foundation. This requires us to slightly change the model, adjusting underlying assumptions to create a more suitable setting for the coup environment. Doing this, we hope to offer a different perspective on the overthrowing of a regime, and to provide a better understanding of when elite members participate in a coup and how the regime can avoid coup attempts. This will hopefully improve our understanding of past, present, and future revolutions.

The ambition with this thesis is not to revolutionise the study of coups d'état, but rather to explore the applicability of an existing model in a new yet similar environment. We hope this can offer an alternative way of deciding participation in a coup.

4 Setup of the Model

Building on the model of provision of discrete public goods developed by Palfrey & Rosenthal (1984), we will set up a model using a game-theoretic approach in order to find an answer to our research question. By solving the model, we will be able to provide an answer to when players participate in a coup d'état and when the coup is successful. The model will also contain properties that could be used in other settings as well as the revolutionary setting on which we are focusing in this paper, such as power struggles between different wings in a political party or possibly even other organisations. This will be discussed further in section 6.

First, we assume that the setting of the game is a country, which is ruled by a group of elites known as the ruling regime. In the country, there is also another group of elites known as the opposition. Nota bene our definition of the opposition differs somewhat from the more common use of the word, which usually includes not only the opposing elite, but rather everyone opposing the ruling regime.

There are two different states enjoyed by the two groups of elites. The current ruling regime enjoys a number of benefits the opposition does not. These benefits may differ between settings. In some settings they may simply be prestige, while in others they may include some monetary benefits, such as access to the treasury. We assume the state enjoyed in power, P, is always better than the state enjoyed in opposition, O, and that each state provides a utility higher than 0. More formally, this can be written as $P > O > 0$. Obviously, this is a very simple version of reality, but it helps to paint the picture of the setting and that is its main purpose. It also provides the opposition with an incentive to stage a coup, as a success would lead to a higher utility.

The group that we are interested in is the opposition, as other groups in society do not have enough resources and therefore not a considerable possibility of staging a coup. The opposition consists of a number of players $i \in \{1,2,\dots,M\}$, which all hold the same belief about the value of a successful coup. Each player can play either participate, $s_i = 1$, or abstain, $s_i = 0$. We assume that the number of players is limited, so that *M* is within a reasonable range, allowing for players to monitor each other in terms of participation in the coup. This is where we deviate from Palfrey & Rosenthal's original model. Even though anonymity is a feasible assumption when studying grassroots revolutions, as the number of players can be as high as a few millions, this would not make sense in a game where the number of players is limited to a reviewable amount.

The assumption of no anonymity and the possibility of monitoring each other allows us to include the possibility of excluding abstaining players from the post-coup state, should the coup succeed. We assume that abstaining and being excluded is associated with a cost, c_2. Following Palfrey & Rosenthal, we also assume that there always is a cost, c_1, associated with participating, whether the coup succeeds or not.

Following Palfrey & Rosenthal, we assume the coup is successful if the number of participants, $m \in \{1,2,\dots,M\}$, exceeds the regime's breaking point, *w*, or more formally, when $m \geq w$. This is a stronger assumption for coups than it is for popular uprisings, as the outcome of a coup is likely to depend on a number of factors, such as whether or not the coup makers are in control of the military, the police etc. However, we argue that it is fair to assume that this is captured in *w* as it affects the breaking point. For example, if the opposition is in control of the military, the breaking point of the regime is likely to be lower than if the military is under regime control. This will be further discussed in section 6.

$m < w$	$s_i = 1$	$u_i = -(c_2 + c_1)$
	$s_i = 0$	$u_i = 0$
$m \geq w$	$s_i = 1$	$u_i = 1 - c_1$
	$s_i = 0$	$u_i = -c_2$

Table 1: Possible pay-offs from different outcomes.

Table 1 outlines the possible pay-offs, u_i, from the different outcomes of the coup depending on whether one participates or not and whether the coup is successful or not. Again, following Palfrey & Rosenthal, the utility from a successful coup has been set to 1 and $0 < c_1 < 1$ so that a successful coup yields a positive utility. If this were not true, there would be no incentive of actually participating in the coup. The cost of not participating in a successful coup or participating in an unsuccessful coup is $0 < c_2 < 1$. This can be thought of as the punishment inflicted by either the ruling regime when the coup is unsuccessful or the opposition when the coup is successful. It can be thought of as a few years in prison, exile, or even death. The cost of participating, c_1, can be seen as time or money invested in the coup attempt. The definitions of the two costs imply that $0 < c_1 < c_2 < 1$.

5 Solving the Model

Following Palfrey & Rosenthal (1984), we divide the *M* players of the opposition into three groups:

G^1: If $i \in G^1, s_i = 1$, so *i* contributes
G^2: If $i \in G^2, s_i = 0$, so *i* does not contribute
G^3: If $i \in G^3$, i has $s_i = 1$ with probability *q*, so *i* uses a mixed strategy

Case 1: Pure Strategy Equilibrium ($|G^3| = 0$)

In the first case, we only allow players to use pure strategies - either participate or abstain. Looking at table 1, it is clear that a player will prefer to participate only if at least $w - 1$ other players are also participating, as this would lead to a successful coup d'état and thus the highest possible utility. It is also clear that a player will always prefer to abstain if he believes that less than $w - 1$ players are participating. This would give him a utility of 0, which is higher than the utility he would have received if he had participated and the coup had failed.

Given that $1 < w \leq M$, it is obvious that there are two equilibria in this case. In the first equilibrium, all players participate and in the second equilibrium all players abstain from participation. If $w = 1$, then there is only one equilibrium where all players participate in the coup. However, if $w > M$, indicating it requires more participants than there are players in the opposition then the only equilibrium will be that no one participates. The equilibrium where all players participate is Pareto efficient when $w \leq M$, as all players receive the highest possible utility ($1 - c_1$).

Case 2: Symmetric mixed strategy equilibria ($|G^3| \neq 0$)

When solving for mixed strategy equilibria, we follow Palfrey & Rosenthal in defining the following variables:

$$k = |G^1|, j = |G^2|, h = \text{number of participants in } G^3$$

and, for $i \in G^3$

$$h_{-i} = \text{number of participants other than } i \text{ in } G^3.$$

That is, *k* and *j* are participating or not participating respectively no matter if $i \in G^3$ decides to play $s_i = 1$. The number of participants in G^3 is h and, given that *i* is in G^3, h_{-i} is the number of participants in G^3 other than *i*.

In equilibrium, all players in G^3 must be indifferent between participating and abstaining. That is, the expected payoffs from participating and abstaining respectively must be equal in equilibrium. We use table 1 to specify the expected payoffs starting with participating:

$$prob\{h_{-i} \geq w-k-1\} * (1-c_1) + prob\{h_{-i} < w-k-1\} * (-c_1-c_2)$$

The first term is the probability of a successful coup d'état given that the player participates, and the second term is the probability of a failed coup given that the player participates. These terms are then used as weights for the payoffs from table 1 to calculate the expected payoff from all possible outcomes of participating in the coup.

The expected payoff from abstaining is:

$$prob\{h_{-i} \geq w-k\} * (-c_2) + prob\{h_{-i} < w-k\} * 0$$

This follows a similar pattern to that of participation in the sense that it is the expected payoff from all possible outcomes of abstaining from participation in the coup. The first term is the probability of success, while the second term is the probability of failure. In equilibrium, these two expressions must be equal. That is:

$$\begin{aligned} prob\{h_{-i} \geq w-k-1\} * (1-c_1) + prob\{h_{-i} < w-k-1\} * (-c_1-c_2) \\ = prob\{h_{-i} \geq w-k\} * (-c_2) \end{aligned}$$

Rearranging this equation to separate the potential benefits from the potential costs, we get the following equilibrium condition for players in G^3:

$$\begin{aligned} prob\{h_{-i} \geq w-k-1\} \\ = c_1 prob\{h_{-i} \geq w-k-1\} + c_1 prob\{h_{-i} < w-k-1\} \\ + c_2 prob\{h_{-i} < w-k-1\} - c_2 prob\{h_{-i} \geq w-k\} \end{aligned}$$

In words, the equilibrium condition for players in G^3 says that the expected utility of being part of a successful coup should be equal to the expected cost of participating less the expected cost of abstaining. This can be further rearranged as $c_1 prob\{h_{-i} \geq w-k-1\} + c_1 prob\{h_{-i} < w-k-1\} = c_1$. This is intuitive, as the expected cost of participating is c_1, regardless of whether the coup is successful or not.

Once again, following Palfrey & Rosenthal, we assume that the probability of being pivotal in regards to the success of a coup is binomially distributed. That is, $prob(h_{-i} = w-k-1) \sim B(M-k-j-1; q)$. This is supported by the assumption that there is symmetry in G^3, which means that all players using mixed strategies have the same probability of participating, *q*, and that each player only choose from two actions – participate or abstain. This allows us to express the equilibrium condition in terms of *w*, *j*, *k*, *q* and *M*:

$$1 - F(w-k-2; M-k-j-1; q) \\ = c_1 + c_2(F(w-k-2; M-k-j-1; q) \\ - \big(1 - F(w-k-1; M-k-j-1; q)\big))$$

In contrast to the popular uprising setting used by Palfrey & Rosenthal, where only the payoff from being pivotal is crucial, we are using the cumulative distribution function. This is due to all situations where player *i* is participating in a successful coup are relevant, as all of them imply a higher utility for playing participate compared to playing abstain.

The equilibrium condition for G^3 can also be expressed in algebraic form:

$$(G^3) \qquad 1 - \sum_{i=0}^{w-k-2} \binom{M-k-j-1}{i} q^i (1-q)^{M-k-j-1-i} = c_1 + \\ c_2 \left(\sum_{i=0}^{w-k-2} \binom{M-k-j-1}{i} q^i (1-q)^{M-k-j-1-i} + \right. \\ \left. \sum_{i=0}^{w-k-1} \binom{M-k-j-1}{i} q^i (1-q)^{M-k-j-1-i} - 1 \right)$$

For players in G^1, the equilibrium condition when we allow for players to use mixed strategies is that the expected payoff from contributing has to be at least as great as the expected payoff from abstaining. That is:

$$prob\{h \geq w-k\} * (1-c_1) + prob\{h < w-k\} * (-c_1 - c_2) \\ \geq prob\{h \geq w-k+1\} * (-c_2) + prob\{h < w-k+1\} * 0$$

Similarly, for the abstaining players in G^2, the equilibrium condition dictates that the expected payoff from participating has to be at most as large as the expected payoff from abstaining. It can be expressed as:

$$prob\{h \geq w-k-1\} * (1-c_1) + prob\{h < w-k-1\} * (-c_1 - c_2) \\ \leq prob\{h \geq w-k\} * (-c_2) + prob\{h < w-k\} * 0$$

As for the equilibrium condition for the players using mixed strategies, the two conditions for the pure strategists can similarly be rearranged and expressed in algebraic forms. The rearranged conditions for G^1 and G^2 are:

$$prob\{h \geq w-k\} \geq c_1 + c_2 prob\{h < w-k\} - c_2 prob\{h \geq w-k+1\}$$

$$prob\{h \geq w-k-1\} \leq c_1 + c_2 prob\{h < w-k-1\} - c_2 prob\{h \geq w-k\}$$

The implications are similar to that of the equilibrium condition for players in G^3. For pure strategy participants, the equilibrium condition states that the probability of being pivotal must be at least as great as the cost of participating less the cost of

abstaining. For pure strategy abstainers, the implication is the reverse, such that the probability of being pivotal must be at most as large as the cost of participating less the cost of abstaining.

Once again, remember that we are assuming binomial distribution for the probability of player *i* being pivotal. The two conditions can be expressed in algebraic form, in terms of *w*, *j*, *k*, *q*, and *M*, as:

(G^1)

$$1 - \sum_{i=0}^{w-k-1} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} \geq$$
$$c_1 + c_2 \left(\sum_{i=0}^{w-k-1} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} + \sum_{i=0}^{w-k} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} - 1 \right)$$

(G^2)

$$1 - \sum_{i=0}^{w-k-2} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} \leq$$
$$c_1 + c_2 \left(\sum_{i=0}^{w-k-2} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} + \sum_{i=0}^{w-k-1} \binom{M-k-j}{i} q^i (1-q)^{M-k-j-i} - 1 \right)$$

The next step is to define the existing equilibria. What this means is that we need to find some values of *q* between 0 and 1 that simultaneously satisfies the equilibrium conditions for G^1, G^2, and G^3 respectively. Following Palfrey & Rosenthal, we note that there are three special cases in which not all of the equilibrium conditions need to be satisfied. If $k = 0$, then only the conditions for G^2 and G^3 need to be satisfied, and similarly, if $j = 0$, then only the conditions for G^1 and G^3 need to be satisfied. Finally, if $k = j = 0$, then only the condition for G^3 needs to be satisfied.

As it is rather difficult to say anything intuitively about the conditions, we will start with a numerical example to try to get a sense of the possible equilibria. The chosen values in the numerical example are arbitrary, and they are meant to be small but feasible. Note that we have chosen the values of the two costs so that the implication of the definitions, $0 < c_1 < c_2 < 1$, is true.

A Numerical Example

$$M = 5, w = 3, c_1 = 0.1, c_2 = 0.2$$

If we only allow pure strategies and $w < M$, we know that we will always have two equilibria – one where all players participate and one where no players participate. In this example, we can express the equilibria as $k = 5, j = 0$, and $k = 0, j = 5$ respectively.

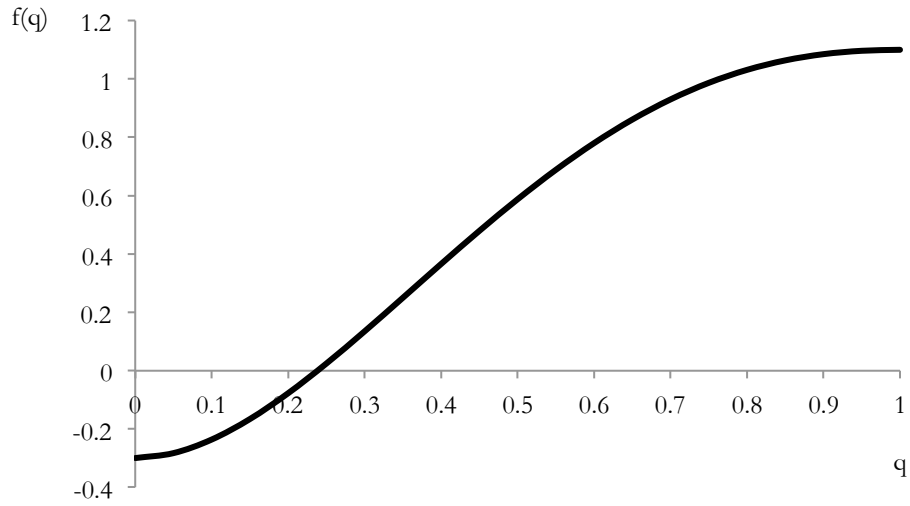


Figure 2: $\boldsymbol{f(q) = 3q^4 - 8.8q^3 + 7.2q^2 - 0.3}$. Equilibrium condition for $\boldsymbol{G^3}$ when $\boldsymbol{k = j = 0}$.

To find the equilibria with mixed strategies, we need to explore all possible cases, starting with the three special cases where not all equilibrium conditions need to be satisfied noted above. For $k = j = 0$, only the equilibrium condition for G^3 needs to be satisfied. The equality that needs to be fulfilled in equilibrium is:

$$1 - \sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i} = 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i} + \sum_{i=0}^{2} \binom{4}{i} q^i (1-q)^{4-i} - 1\right)$$

Rearranging this equation, we get a quartic polynomial:

$$0 = 3q^4 - 8.8q^3 + 7.2q^2 - 0.3$$

The solution that satisfies this condition is $q \approx 0.239$. This is within our relevant interval of $0 < q < 1$, and to confirm that this is indeed the only relevant answer, we plot the equation as a graph. As we can see in figure 2, $q \approx 0.239$ is the only answer that satisfies both the equilibrium condition and the condition for the value of *q*. As we assume symmetry in G^3, so that all players have the same *q*, the value of *q* gives us the total level of participation. In this case we would expect 1.2 players to participate. We would thus expect under-participation in equilibrium, as $1.2 < w = 3$.

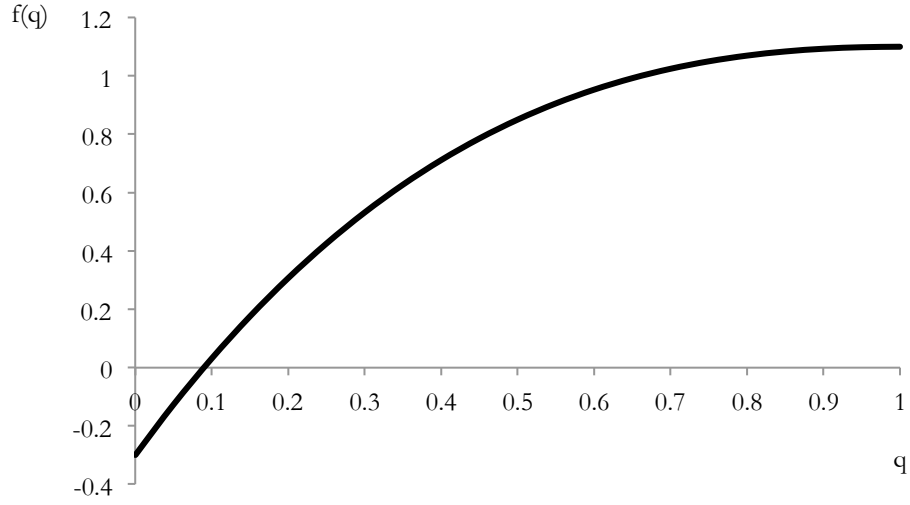


Figure 3: $\boldsymbol{f(q) = 0.8q^3 - 3q^2 + 3.6q - 0.3}$. Equilibrium condition for $\boldsymbol{G^3}$ when $\boldsymbol{j = 0}$ and $\boldsymbol{k = 1}$.

For $j = 0$ and $k \neq 0$, the equilibrium conditions for both G^3 and G^1 need to be satisfied. The only relevant number of pure strategy participants in this case is $k = 1$. The equilibrium conditions for G^3 and G^1 respectively is:

$$1 - \sum_{i=0}^{0} \binom{3}{i} q^i (1-q)^{3-i} = 0.1 + 0.2\left(\sum_{i=0}^{0} \binom{3}{i} q^i (1-q)^{3-i} + \sum_{i=0}^{1} \binom{3}{i} q^i (1-q)^{3-i} - 1\right)$$

$$1 - \sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i} \geq 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i} + \sum_{i=0}^{2} \binom{4}{i} q^i (1-q)^{4-i} - 1\right)$$

We begin by solving the equilibrium condition for G^3 in order to get the value(s) of q that satisfies the equality. We then test if any of the values also satisfies the condition for G^1. Rearranging the condition for G^3 we get the following cubic polynomial:

$$0 = 0.8q^3 - 3q^2 + 3.6q - 0.3$$

The solution to this condition, given $0 < q < 1$ is $q \approx 0.090$. Once again we show graphically that this is indeed the only solution in the relevant interval of q (see figure 3). To test whether this is an equilibrium or not, we need to make sure that $q \approx 0.090$ satisfies the equilibrium condition for G^1 as well. We get:

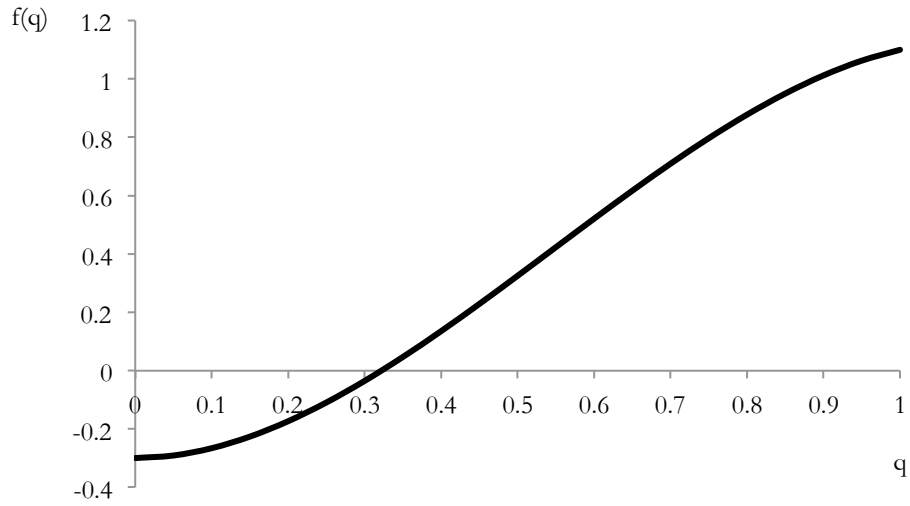


Figure 4: $\boldsymbol{f(q) = -2.2q^3 + 3.6q^2 - 0.3}$. Equilibrium condition for $\boldsymbol{G^3}$ when $\boldsymbol{k = 0}$ and $\boldsymbol{j = 1}$.

$$0.043 \geq 0.291$$

which obviously is not true. This means that this is not an equilibrium since it does not satisfy both equilibrium conditions.

For $k = 0$ and $j \neq 0$ the equilibrium conditions for both G^3 and G^2 need to be satisfied. The relevant number of pure strategy abstainers is $j = 1$ and $j = 2$. If $j \geq 3$, then $M - j = 5 - 3 = 2 < w = 3$, which means that it is not possible to stage a successful coup d'état. When $j = 1$ we need to satisfy the following two conditions:

$$1 - \sum_{i=0}^{1} \binom{3}{i} q^i (1-q)^{3-i}$$
$$= 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{3}{i} q^i (1-q)^{3-i} + \sum_{i=0}^{2} \binom{3}{i} q^i (1-q)^{3-i} - 1\right)$$

$$1 - \sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i}$$
$$\leq 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{4}{i} q^i (1-q)^{4-i} + \sum_{i=0}^{2} \binom{4}{i} q^i (1-q)^{4-i} - 1\right)$$

Rearranging the first equilibrium condition (G^3) we get the following cubic polynomial:

$$0 = -2.2q^3 + 3.6q^2 - 0.3$$

The solution to this equality is $q \approx 0.322$. Just as before, we confirm that this is the only solution for $0 < q < 1$ in figure 4. Testing whether this is a solution to the equilibrium condition for G^2 as well gives the following inequality:

$$0.387 \leq 0.202$$

Since this inequality is false, this is not an equilibrium.

When $j = 2$, the following conditions need to be satisfied in equilibrium. Remember that $k = 0$.

$$1 - \sum_{i=0}^{1} \binom{2}{i} q^i (1-q)^{2-i} \\ = 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{2}{i} q^i (1-q)^{2-i} + \sum_{i=0}^{2} \binom{2}{i} q^i (1-q)^{2-i} - 1\right)$$

$$1 - \sum_{i=0}^{1} \binom{3}{i} q^i (1-q)^{3-i} \\ \leq 0.1 + 0.2\left(\sum_{i=0}^{1} \binom{3}{i} q^i (1-q)^{3-i} + \sum_{i=0}^{2} \binom{3}{i} q^i (1-q)^{3-i} - 1\right)$$

Rearranging the first condition yields the following quadratic polynomial:

$$0 = 1.2q^2 - 0.3$$

The solution to this equality within the relevant interval of q is $q = 0.5$. Since this is a simple quadratic polynomial, we do not need to confirm that this is the only relevant solution. Inserting $q = 0.5$ into the condition for G^2 yields:

$$0.500 \leq 0.175$$

Once again, we get a false inequality, which means that this is not an equilibrium.

The final set of cases for this numerical example is where $k \neq 0$ and $j \neq 0$. More specifically, we will test $k = 1, j = 1$ and $k = 1, j = 2$. The following equilibrium conditions, where the first is for G^3, the second is for G^1 and the third is for G^2, need to be satisfied:

$$1 - \sum_{i=0}^{1-k} \binom{4-k-j}{i} q^i (1-q)^{4-k-j-i} = 0.1 + 0.2\left(\sum_{i=0}^{1-k} \binom{4-k-j}{i} q^i (1-q)^{4-k-j-i} + \sum_{i=0}^{2-k} \binom{4-k-j}{i} q^i (1-q)^{4-k-j-i} - 1\right)$$

$$1 - \sum_{i=0}^{2-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} \geq 0.1 + 0.2\left(\sum_{i=0}^{2-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} + \sum_{i=0}^{3-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} - 1\right)$$

$$1 - \sum_{i=0}^{1-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} \leq 0.1 + 0.2\left(\sum_{i=0}^{1-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} + \sum_{i=0}^{2-k} \binom{5-k-j}{i} q^i (1-q)^{5-k-j-i} - 1\right)$$

Starting with $k = 1, j = 1$, a rearrangement of the condition for G^3 yields the following polynomial:

$$0 = -q^2 + 2.4q - 0.3$$

The solution satisfying the condition is $q \approx 0.132$. This indicates that 0.396 players from the "mixers" will participate. In order for this to be an equilibrium, the other two conditions need to be satisfied as well. Inserting $q \approx 0.132$ yields the following inequalities, where the first is the condition for G^1 and the second is the condition for G^2:

$$0.048 \geq 0.290$$

$$0.347 \leq 0.221$$

As neither of the conditions are satisfied, this case is not an equilibrium. Assuming that $k = 1$ and $j = 2$, a rearrangement of the equilibrium condition for G^3 yields the following equality:

$$0 = 1.2q - 0.3$$

The solution to the equality is $q = 0.25$, which means that we expect 0.5 players from G^3 to participate. Inserting $q = 0.25$ into the other conditions yields the following inequalities:

$$0.0625 \geq 0.2875$$

$$0.4375 \leq 0.2$$

Once again, neither inequality is true, which means that this is not an equilibrium. We conclude that in this numerical example there is only one mixed strategy equilibrium, where $k = j = 0$. We can also conclude that in this equilibrium, we expect under-participation and thus an unsuccessful coup d'état.

It is clear from this numerical example that the equilibria with under-participation (or over-participation for that matter) are not efficient. In all equilibria where $k \neq M$ or $j \neq M$, there is a possibility for some players to change their action to receive a higher utility. Consider for example the equilibria in the numerical example above where $k = j = 0$. In this equilibrium we expect 1.2 players to participate, but 3 players are required for the coup to be successful. This means that the 1.2 players participating receive a utility of -0.3, but by changing their action to abstain, they could instead achieve a utility of 0. Similarly, if there exist equilibria with over-participation, all players playing abstain could change their action to participate to increase their payoff from $-c_2$ to $1 - c_1$.

This means that we can conclude with a simple strategy rule for all players: participate if and only if $m_{-i} \geq w - 1$ where m_{-i} is all participants except player *i*. In all other situations, abstaining is the dominant strategy.

We will not consider a dynamic version of this model as it is not feasible considering the payoffs from an unsuccessful coup discussed in the set-up of the model. This is therefore a purely static model, with only one event: players choosing to abstain or participate. This implies a trust game or a coordination game, as the players in the opposition need to coordinate their action on participation and then trust each other to actually play participate. Without any coordination, a risk-minimising individual would prefer to play abstain, as this gives a payoff of 0. Being the only player playing participate would yield a lower utility of $-c_1-c_2$, as long as $w > 1$. This means that the opposition needs to coordinate and trust each other to reach their goal of a successful coup.

6 Extended Thoughts and Variations

In this section, we allow ourselves to speculate about implications of changing or removing assumptions. We begin by allowing for incomplete information regarding the regime's breaking point, and then move on to allowing for more than two actions. Finally, we briefly talk about further applications of the model.

Allowing for incomplete information

When there is complete information we assume all players know w. The opposition knows exactly how many players are required to perform a successful coup d'état and the ruling regime knows their defences. If we instead challenge the assumption of complete information, which would make a coup strictly about coordination, other factors will play a more substantial role. Assuming costs of participation and abstaining as well as benefits from ruling are still known to all players, while relaxing the assumption of a known w, the setting is changed.

A model including some type of signalling effect by the ruling regime or even a third party of their private information about w, will affect how players in the opposition respond. The loyalty of the military is empirically the most important factor to decide whether a will be successful or not and as long as regimes keep control of this loyalty, opponents are usually unable to dismantle the elite who controls government (Belkin & Schofer, 2003). Examples of signalling could be if a well-reputed general criticises the government in media indicating disunion or if the government starts buying arms indicating the military is weak. However, signals may also have a negative impact on the ruling regime, increasing the possibility of a coup attempt. Policy traps, or sending unwanted signals, could affect the ruling regime's aspiration negatively (Angeletos et. al. 2006). Dismissing an old general and recruiting a new one could either send a signal of division or talent embracing.

When taking a closer look at w in a setting with incomplete information, the first objective is to decide who has the private information about w. Assuming the military is the most important factor that affects w, so that w is some function of the military, the second part is to decide whether the military is given, endogenous, or an independent player. The military could even be seen as a wing within the ruling regime, in a setting described by Dewan & Myatt (2007), where the political leader would have to win support in his or her own camp before being able to maintain a high w. Signalling a division within the ruling regime would indicate a lower w, thus making an attempt a more tempting option.

Another setting could be that the regime itself sends some type of signal in order to create a popular estimation of a higher w than it objectively is, thus using propaganda (Edmond, 2013). The problem with this assumption and therefore signalling effect is that everyone knows the possibility of propaganda. This lays ground for a setting where strong regimes with loyal military leaders may be subject to coup attempts as it

is not possible to distinguish between high and low *w*'s as both use propaganda. In order for the signal to be decisive the cost of signalling has to be too high for weak regimes with disloyal militaries to be able to imitate signals (Leland and Pyle, 1977).

Extending our model and taking these factors into consideration, *w* would be some function, *f*, of military loyalty, police loyalty etc. Opening up for a two or more stage game would allow for these institutions to signal where their loyalty lies, thus affecting the players' perception of *w*. This could also assist coordination, as a signal of loyalty to the opposition from the military would most likely increase the probability of players playing participate. The reverse is of course also true, and could be used by the regime as a tool for decreasing the likelihood of participation. It is, however, important to note that the signal will have different strength depending on where it comes from. If a general in the military declares his loyalty, it would be seen as stronger than if a member in the regime or the opposition declares the military's allegiance, since there is a perceived risk of propaganda.

Allowing for more than two options

Our model is limited to two options, either participating or abstaining. A real decision made in this scenario would include at least three options: participating in the coup, supporting the ruling regime, or remaining neutral. Due to the cost of not participating being very high and rising for the higher levels in the elite hierarchy, remaining neutral is often not profit-maximising for high governmental officials (Tullock, 2005, p. 261). There could, however, be more neutral players in a two-stage game where they are temporary neutral in the first stage in order to count their odds. This cost of temporary neutrality, a doubt cost, may be notably lower than permanent neutrality.

Adjusting our own model for a third option of supporting the regime, we can prove that neutrality (abstaining) is never an attractive option assuming complete monitoring of players' behaviour is still at play. This means that no matter which wing of the elite comes successful out of the coup, the neutral player will be seen as a non-supporter of that wing, and will therefore be the subject of retribution. In other words, the action of remaining neutral always yields a utility of $-c_2$.

Joining the winning side yields a utility of $(1 - c_1)$ and joining the losing side yields a utility of $(-c_1 - c_2)$. The expected payoff from remaining neutral is $-c_2$, while the expected payoff from joining either side is $prob\{m \geq w\} * (1 - c_1) + prob\{m < w\} * (-c_1 - c_2)$. If the probability of succeeding equals the probability of failing so that $prob\{m \geq w\} = prob\{m < w\} = 0.5$, the expected payoff is $0.5 - c_1 - 0.5c_2$. The decision rule is therefore to join either side when

$$-c_2 < 0.5 - c_1 - 0.5c_2$$

or equivalently when

$$c_1 < 0.5 + 0.5c_2$$

Since $1 > c_2 > c_1 > 0$ by definition, this will always be true. If the probability of success is higher than the probability of failure, say 0.75 and 0.25, the expected payoff is $0.75 - c_1 - 0.25c_2$. The decision rule is thus to join the side with the higher probability of winning if

$$-c_2 < 0.75 - c_1 - 0.25c_2$$

or equivalently if

$$c_1 < 0.75 + 0.75c_2$$

Once again, this will always be true. We have thus proven it is never optimal to remain neutral in a situation with complete monitoring of action as the expected payoff from joining the winning side (or either side when the probabilities of success are equal) is always higher than that of remaining neutral.

Further applications

We would argue that our model, especially with three options, is applicable in settings other than violent coups. For example, it can serve as a model for internal struggles in a political party or even in the management of a corporation. Adjusting the costs to better mirror the reality in these settings is fairly straightforward, but will not be further explored in this thesis.

7 Conclusion

In this thesis, we have set-up a game-theoretic model based on the model of public good provision developed by Palfrey & Rosenthal (1984) to answer the question of when players participate in a coup d'état.

We have shown that a player's decision to participate in or abstain from participation in a coup d'état setting depends on their perception of the ruling regime's breaking point, w. If a player believes he will be pivotal to the outcome of the coup or that the coup would be successful even without his participation, he will always play participate. On the other hand, if he believes he will not be pivotal and that all other participants are not numerous enough to reach the regime's breaking point, he will always prefer to abstain. This implies that with no signalling, a rational player faced with a one-period decision of participating or abstaining will abstain if his perception of w is sufficiently high.

8 Bibliography

Angeletos, G., Hellwig, C., and Pavan, A. 2006, Signaling in a global game: coordination and policy traps. *Journal of Political Economy* 114(3), pp. 458-462

Belkin, A., and Schofer, E. 2003, Toward a structural understanding of coup risk. *The Journal of Conflict Resolution* 47(5), pp. 594-620

Bueno De Mesquita, E. 2010, Regime change and revolutionary entrepreneurs. *American Political Science Review* 104(3), pp. 446-450

Casper, B. A., and Tyson, S. A. 2014, Popular protest and elite coordination in a coup d'état. *Journal of Politics* 76(2), pp. 548-564

Dewan, T., and Myatt, D. P. 2007, Leading the party: coordination, direction, and communication. *American Political Science Review* 101(4), pp. 828-832

Edmond, C. 2013, Information manipulation, coordination, and regime change. *Review of Economic Studies* 80(4), pp. 1424-1426

Kramnick, I. 1972, Reflections on revolution: definition and explanation in recent scholarship, *History and Theory* 11(1), pp. 26-63

Leland, H. E., and Pyle, D. H. 1977, Information asymmetries, financial structures, and financial intermediation, *Journal of Finance* 32(2), pp. 371-387

Lichbach, M. I. 1994, What makes rational peasants revolutionary?: dilemma, paradox, and irony in peasant collective action. *World Politics* 46(3), pp. 383-418

Lohmann, S. 1993, A signaling model of informative and manipulative political action. *American Political Science Review* 87(2), pp. 319-333

Lohmann, S. 1994, Dynamics of informational cascades: the Monday demonstrations in Leipzig, East Germany, 1989-1991. *World Politics* 47(1), pp. 42-101

Lohmann, S. 2000, Collective action cascades: an informational rationale for the power in numbers. *Journal of Economic Surveys* 14(5), pp. 655-684

Olsson-Yaouzis, N. 2012, An evolutionary dynamic of revolutions. *Public Choice* 151(3-4), pp. 497-515

Oxford Dictionaries. N.d., *"revolution" definition 1* [online] Available from http://www.oxforddictionaries.com/definition/english/revolution [Accessed on 2015-04-23]

Palfrey T. R., and Rosenthal H. 1983, A strategic calculus of voting. *Public Choice* 41(1), pp. 7-53

Palfrey T. R., and Rosenthal H. 1984, Participation and the provision of discrete public goods: a strategic analysis. *Journal of Public Economics* 24(2), pp. 171-193

Stone, L. 1966, Theories of revolution, *World Politics* 18(2), pp. 159-176

Sutter D. 2000, A game-theoretic model of the coup d'état. *Economics and Politics* 12(2), pp. 205-223

Tullock, G. 2005, *The social dilemma: of autocracy, revolution, coup d'état, and war / Gordon Tullock; edited and with an introd. by Charles K. Rowley*, Indianapolis: Liberty Fund, Inc.