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BAKALÁŘSKÁ PRÁCE

War of attrition in delayed stabilizations

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Prohlášení

Prohlašuji, že jsem bakalářskou práci vypracovala samostatně a použila pouze uvedené prameny a literaturu

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Poděkování: Zde bych ráda poděkovala svému konzultantovi PhDr. Martinu Gregorovi PhD. za jeho obětavost a jeho pomoc při orientaci v tématu a psaní bakalářké práce

Abstrakt

Četná evidence potvrzuje, že státy v mnohých případech spějí k rozpočtové nerovnováze způsobené např. vysokou inflací a odkládají stabilizaci veřejných financí. Tento jev v bakalářské práci vysvětluji skrze konflikt dvou socioekonomických skupin pomocí modelu war of attrition (válka opotřebení).

Nejprve představím základní prvky teorie her, které v práci budu používat. Dále uvedu modely popisující zpožděnou stabilizaci a popíši proces hledání buď Bayesovské nebo dokonale Bayesovské rovnováhy (PBE). Po určení rovnováhy, se budu věnovat komparativním statikám a zkoumat faktory způsobující dřívější či pozdější stabilizaci. V závěrečné části zkoumám vliv, který mají na stabilizaci doplňkové faktory jako je krize, zahraniční pomoc, vnější zásah, existence předvolebního období, ideologická orientace skupin a koheze uvnitř skupiny.

Abstract

It happens very often, and existing evidence supports it, that countries run politics of large public deficit or increased inflation and permanently postpone stabilization although they know that those politics are unsustainable in the long run. We explain this phenomenon as conflict between two interest groups and we model it as a war of attrition. Firstly, we present the basic elements of game theory, which we will use in this thesis. Then, we introduce the models of delayed stabilization and we describe the process of finding Perfect Bayesian equilibrium (PBE). Afterwards, we investigate in comparative statics the factors delaying or hastening the stabilization. In the final section we examine how is the time of stabilization influenced by factors as crisis, foreign aid, external intervention, election period, ideological orientation of groups and cohesion within group.

Contents

Chapter 1

Introduction

Many countries are implementing policies which are unsustainable in the long run. Nowadays, numerous developed economies pursue generous public spending which enlarges budget deficits. According to recent research activity investigating fiscal policy, the tendency to postpone necessary stabilizations of budget deficits is a current problem of many countries. Even though the required stabilization might be postponed for some time, it cannot be postponed infinitely. It is therefore a puzzle why countries keep on enlarging budget deficits, although they know that reform is unavoidable. As the stabilization delay varies country to country, there certainly exist factors which influence its reduction or enlargement. In this thesis, we would like to examine closely the nature of delayed stabilizations and reasons, which may lead to them.

1.1 Delayed stabilizations: concept

To explain, why countries tend to postpone necessary reforms, we introduce the model of war of attrition, which was firstly applied in the area of delayed reforms by Alesina and Drazen (1991). The main assumption of the model is that there are two powerful interest groups who live in unbalanced economy and who disagree about how the reform should be implemented. They propose very dissimilar policies, so either first one or the other one can be applied. It is not possible to combine them.

Living in unreformed economy is not easy and both interest groups suffer from it which prevents them to maintain status quo forever. For stabilization to happen one group has to resign about its way of implementation and accept the solution of the other group. Any group gives up only when its opponent demonstrates strength so great that the group is persuaded about its defeat. Any way of stabilization requires both groups to bear some adjustment costs, which are higher for a party which gives up first. Hence, groups argue about who should bear higher stabilization costs (Hsieh, 2000).

1.2 War of attrition – original concept

The concept of war of attrition was firstly designed by John Riley (1980). On the example of two fighting animals, we will shortly describe this idea and show the basic assumptions. This original war of attrition model related to the area of biology. The idea is that there are two animals fighting over the prize.

First assumption necessary for our model is that fighting is costly. Secondly, the one, who wins – Winner – get the prize and will be better off. The other one will become Loser – e.g. will be worse off in comparison to the period preceding the fight. Therefore, each animal has two contending incentives. On one hand, it wants to fight because winning prize would improve its future welfare. On the other hand, when already started, the fighting is costly, so each of two contestants wants the fight as short as possible. The fight is ended when one of the animals gives up and the other one wins the prize. If the two animals had exactly identical costs of fight, they would concede at one time and there would be no Winner and no Loser. The third assumption is therefore that the contestants are not identical and each of them has his „ideal“ time of concessions which is derived from his personal loss of the utility during the fight and which is known only to him. In this example, one can imagine that two animals differ in initial amount of the strength which they need in the fight or that they become exhausted of the fight sooner or later depending on their personal abilities and also on individual perception of circumstances of the fight.

The animal concedes when its marginal utility (probability of winning the prize multiplied by the gain) equals its marginal cost (cost of staying in the fight multiplied by the probability of being the loser). Another moment of staying in the fight would not be advantageous for him anymore.

As we can see, there exists clear parallel between interest groups disputing over the costs of stabilization and two fighting animals. There same assumptions in both cases, which helps us to model delayed stabilization as a war of attrition.

1.3 Structure of the thesis

In the second part, we will present theory which is essential for modeling war of attrition. We will briefly introduce basics of game theory, explain mixed and Bayesian equilibrium and define some key terms. Next, we will discuss the idea of beliefs updating, which will be used in war of attrition model a lot, and finally, we will adopt the concept of Perfect Bayesian equilibrium.

In the third part of this thesis, we will present two models of delay stabilization. In the first model, the fight between two interest groups will take place during two periods only. However this model will help us to explain easily the mechanics of modeling delayed stabilization. In the second model, the length of delay will not be restricted, which means that stabilization can take place in infinitely many periods. We discover two Bayesian equilibria – one with a delay and the other one without, however there is single equilibrium which satisfies subgame perfectness. For this particular equilibrium, we will discuss comparative statics.

In the third part of the paper, we will analyze other factors possibly influencing the delay. Specifically, we will discuss the influence of severe crisis and foreign aid on the stabilization delay. Furthermore, we will present how external intervention, electoral cycle, ideological orientation of the parties and cohesion within groups influences stabilization time.

Chapter 2

Theory: Equilibrium in one period

2.1 Mixed equilibrium

In this part, we present the theoretical background that will be used in the war of attrition model. We begin by introducing basics of game theory. We establish the terminology, set the concept of mixed strategies games and describe how to find pure and mixed Nash equilibrium in a game. Then, we show, how the mixed strategy game can be transformed into game of incomplete information, where uncertainty about opponent forces the players to link their strategies with the beliefs about opponents' type.

In the games of incomplete information, the strategies (or types) of players are chosen by the Nature, whereas everybody knows only his own strategy profile. Players do not mix between the strategies, but each player has to play the type, which was chosen for him by the Nature. We do not search for pure or mixed equilibria as before, but for Bayesian equilibrium, which is determined by both strategies and beliefs of the players. The theoretical concept of Bayesian equilibrium is illustrated by the examples, which are supposed to maintain link with reality.

Bayesian equilibrium relates to game played in one single period. Nevertheless, we rarely encounter in reality problem which does not develop in the time. Therefore to add here the time dimension, we discuss beliefs updating and Perfect Bayesian equilibrium, which serves us as a basis for explaining the game of incomplete information in time. Beliefs updating and Perfect Bayesian equilibrium are crucial for us to understand war of attrition model.

2.1.1 "Will the state bankrupt?"game

Firstly, let us introduce the idea of Chicken game, which will help us present mixed strategies and games with Bayesian beliefs. In original Chicken game, there are two drivers riding the car on one road one against the other. Each of them can either go (continue in straight direction) or turn. The one, who turns as the first, is a chicken. If no player turns, there is a crush and both players die. It may also happen that both players turn and no one dies.

To approach the idea of stabilization, which will be modeled later on, we will change the story behind. Nonetheless, the structure of model itself will not change. There is one country, and two interest groups living inside - Consumers and Firms. The economy is in deep crisis. Government is indebted to foreign countries and monetary fund. Unfortunately, the reserves are depleted and country has to return the money back.

Therefore, country needs extra taxes at least from one of the groups and each group decides individually whether it wants to pay Taxes of to Free Ride. However, if a country receives no taxes from any group, it will become uncertain target for investors and will be considered as insolvent. Consequently, as the government of a country will be incapable to pay off its debts, foreign investors will stop to demand governmental obligations and generally will limit contact with this country. To avoid the consequences of exclusion from international cooperation, country will need to perform painful reforms. Such a situation of country's insolvency negatively affects both Consumers and Firms. Either Consumers or Firms have the choice to pay the taxes and save the government. But each group would be definitely better off, if the other one is the rescuer. This game might look as follows:

Figure 1: "Will the state bankrupt?"game

	Firms	
	T	**FR**
T **Consumers**	0,0	-1,1
FR	1,-1	-2,-2

Consumers are horizontal player (usually player 1), i.e. they decide between up and down part of the game and their payoff is the first one. Firms are vertical player(usually player 2), i.e. they decide between left and right part of the game and their payoff is the second one. We assume that both groups choose one individual fully representing opinion of whole group, who is responsible of playing the game. Therefore even though we use notation "Consumers" and "Firms", the game is played by only two players.

2.1.2 Nash equilibrium in pure strategies

In this game, we assume that both players have **complete information**, i.e. Consumers know their own payoffs and the different payoffs of the firms and vice versa. Both players can make

two **actions**. Consumers and Firms decide (independently on each other) to play Taxes or to Free Ride. This game has four possible **outcomes**. Either can both players decide to pay the Taxes or to Free Ride, either can one of them play Taxes and the other one Free Ride.

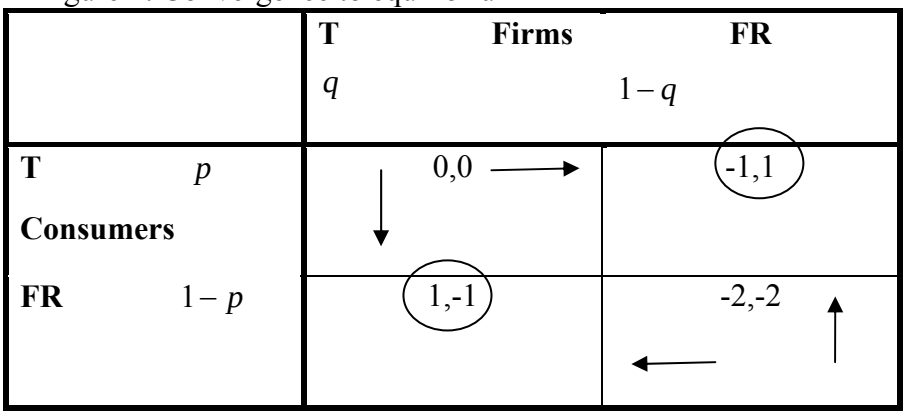
Firms and Consumers are quite interested of their payoffs. Thereby, because the opponent determines their final payoff too, they do not decide randomly about their actions. but they plan. Each of them creates the strategy for two different situations – i.e. when the opponent plays Taxes or when he Free Rides. So both, Consumers and Firms, pick the action, which is the **best reply** (or **best response**) on what their opponent does (Gregor, 2009). Those strategies consequently lead to the equilibrium, a result of the game, from which no one has incentive to deviate.

It may happen (not presented here), that the best reply of Consumers on any action played by the Firms will be always Taxes. In that case, playing taxes will be **dominant strategy** of Consumers (Rasmusen, 2007), because they cannot be better off by doing any other action, no matter what Firms do. Under these conditions, Firms decide to take the action, which maximizes their payoff. Then, considering that one action (let us say Free Ride) brings Firms higher payoff than the other one, Consumers will always play Taxes and Firms Free Ride. As no one has incentive to deviate from this point, players are in equilibrium.

However, the game in Figure 1 is not that simple as the example presented. When Firms decide to pay Taxes, the best response of Consumers is to Free Ride, because they get payoff of 1, while paying of Taxes would reward them with payoff of 0. However, when Firms decide not to pay Taxes, Consumers will prefer to sacrifice their own money and avoid state's Bankruptcy. The same holds for Firms. Therefore, no strategy will be dominant and there will be more than one equilibrium, particularly in this case two **pure Nash equilibria,** (T,FR) and (FR,T) from which neither Consumers, nor Firms have incentive to deviate.

Why do they not deviate? Let us consider equilibrium (T,FR) where Consumers have payoff -1 and Firms have payoff 1. If Consumers try to deviate and avoid paying Taxes, they will be worse off because of Bankruptcy. If Firms try to deviate, and pay Taxes, their payoff will decrease to 0, so either for them, it will not be optimal. In short, if the players are in the equilibrium, they do not deviate. However, if they are out of the equilibrium, they deviate and converge to one of the two equilibria. We can show this on the Figure 2.

Figure 2: Convergence to equilibrium



2.1.3 Nash equilibrium in mixed strategies

Probability that Consumers play Taxes is denoted as p ($1-p$ is the probability of Free Ride) and probability that Firms play Taxes is denoted as q ($1-q$ is the probability of Free Ride). Players act simultaneously, which means that, before they play, they do not observe the action played by the opponent. However, both Consumers and Firms know the **probability** q or p that their opponent will play Taxes. In the Mixed strategy model, each player can play what is called **mixed strategy**, i.e. playing Taxes with some probability p or q and Free Riding with $1-p$ or $1-q$**.**

Thus, beyond two pure equilibria, we have also mixed equilibrium, in which Consumers and Firms are playing actions in probabilities. Identically to pure strategies, Consumers and Firms adjust their own probabilities with which they play the actions to those of their opponent and through this process, they get to the equilibrium.

Let us consider that Firms play Taxes with probability q. Then, if the probability q is high enough, Consumers will decide to Free Ride and if it is low (in this case it is not probable that Firms decide to pay Taxes) Consumers will prefer to play Taxes. Not surprisingly, there is also one level of q, at which Consumers will be indifferent between Taxes and Free Ride. For this q**,** it holds that the expected payoff of playing Taxes $\pi(q)_1^T$ is the same as expected payoff of playing Free Ride $\pi(q)_1^{FR}$.

$$\pi(q)_1^T = \pi(q)_1^{FR} \tag{1}$$

$$q \times 0 + (1-q) \times (-1) = q \times 1 + (1-q) \times (-2)$$

$$q = 1/2$$

Thus, we know that q, at which Consumers will be indifferent between Taxes and Free Ride is equal to $1/2$. Because the game is symmetric, Firms are indifferent between Taxes and Free Ride when Consumers choose each of them with probability $1/2$. Therefore $(p,q) = \{1/2, 1/2\}$ is mixed Nash equilibrium in this game. As we saw, we can model the game between Consumers and Firms through Mixed Strategies, when each player realizes his strategy (Taxes, Free Ride) with some probability.

2.2 Behavior under incomplete information

2.2.1 Bayesian equilibrium

For some people it may seem unnatural to imagine Consumers and Firms behaving on the markets with explicitly defined probabilities of doing actions. Hence, we introduce a concept working on the same principle but which does not require players to mix between their strategies (Gregor, 2009). The actor who is choosing the actions instead of players is here the **Nature**.

In the first turn, before Consumers and Firms enter the game, Nature plays its part and chooses types of the players. Player plays his action with respect to the type that he is. Nature is regarded as a pseudoplayer. It plays its actions randomly but with specified probabilities and at specified time - in this case at the beginning of the game (Rasmusen, 2007). According to how Nature decides, Consumers or Firms play either Taxes or Free Ride, nothing in between. Nature chooses types of players with probabilities that are known to the players. However, each player knows only his own type.

As already said, players are not mixing in this game. Instead of mixing, each player has some beliefs about the strategy that his opponent intends to play (because he does not know his opponent's type) and he creates his own strategy with respect to those beliefs. Thus, maximizing their expected payoff and with regard to their beliefs, players converge to equilibrium which is called Bayesian. This equilibrium is defined not only though strategies but also through beliefs of players.

2.2.2 Extra costs of Bankruptcy

Now, we already explained the concept of Bayesian equilibrium. To analyze the process leading us to Bayesian equilibrium, we will consider modified version of the previous "Will

the country bankrupt?" game (Gregor, 2009). We introduce variations in payoffs of the outcome (FR, FR). In addition to his payoff (-2) each player receives utility drawn from the values $\{+\theta, -\theta\}$. We may envisage that, when the country cannot repay its debts, each player has some welfare losses, which might be larger or smaller depending on his luck. The luck is represented in this game by Nature that randomly chooses for a player either larger or smaller losses. Thus, there is Low type of the player $(-\theta)$, who has large losses and High type of the player $(+\theta)$, who has small losses. Naturally, player will be more consenting to pay Taxes, if his utility in Bankruptcy is Low $(-2-\theta)$ than when it is High.

Nature chooses either Low o High type (with large and small losses respectively) for both players, Consumers and Firms. They cannot deviate from the type, which Nature selected for them and they know only their own type, not the type of their opponent. They only know that Nature chooses each type of player with probability $1/2$, therefore each type of their opponent is chosen with $1/2$ probability. As Nature can choose for each player two types, there exist four cases of one game represented in the Figure 3.

Figure 3: Cases of "Will the state bankrupt?" game

	$+\theta$		$-\theta$	
$+\theta$	0,0	-1,1	0,0	-1,1
	1,-1	-2+θ, -2+θ	1,-1	-2+θ, -2-θ
$-\theta$	0,0	-1,1	0,0	-1,1
	1,-1	-2-θ, -2+θ	1,-1	-2-θ, -2-θ

Both Consumers and Firms know (through their beliefs) the expected probability q^e that opponent plays Taxes. There exists a critical probability level q at which, if played by Firms, Consumers are indifferent between choosing Taxes and Free Ride. This level q is for $+\theta$ type q^H and for $-\theta$ type q^L. Both Consumers and Firms have to compare the expected probability q^e that the opponent will choose Taxes with their own critical probability value,

q^H or q^L, which is derived from their type and at which they are indifferent between the actions. Only then, they can decide about their strategy (Gregor, 2009).

As q^e of the opponent is given exogenously, to determine the player's strategy we have to calculate only critical q for Low and High type of player. We know that in the original game, the probabilities at which players felt indifferent between actions were: $p = q = 1/2$. This does not hold in this case, because we need to include Bankruptcy losses of the players. We again pose expected payoff from playing Taxes of both Low type and High type equal to that of playing Free Ride.

Low type:

$$\pi_L^T(q^L) = \pi_L^F(q^L)$$
$$-(1-q) = q + (1-q)(-2-\theta) \tag{2}$$
$$q^L = \frac{1+\theta}{2+\theta}$$

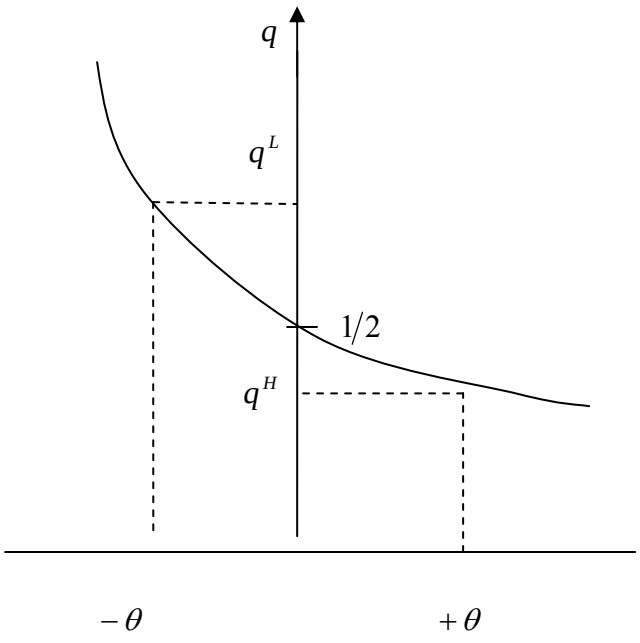
High type:

$$\pi_H^T(q^H) = \pi_H^F(q^H)$$
$$-(1-q) = q + (1-q)(-2+\theta) \tag{3}$$
$$q^H = \frac{1-\theta}{2-\theta}$$

$$q^L = \frac{1+\theta}{2+\theta} > \frac{1-\theta}{2-\theta} = q^H \tag{4}$$

As we can see in equation (4), lower utility $-\theta$ from Free Riding increases the probability of playing Taxes and higher utility $+\theta$ from Free Riding has exactly the opposite effect. The difference between q^L and q^H is also depicted on Graph 1.

Figure 4: Probabilities of Taxes for Low/High costs player



The value of q^L and q^H represents the value at which Low and High types of players are indifferent between choosing Taxes and Free Ride strategy. As we can see clearly at Figure 4, q^L is higher than q^H, therefore the probability of playing Taxes is higher for the Low type of the player, i.e. the player who has larger welfare losses. Let us remind that Consumers choose between p and $1-p$, whereas Firms choose between q and $1-q$. Symmetry ensures that beliefs and also critical probability values for Low and High type are same for Consumers and Firms.

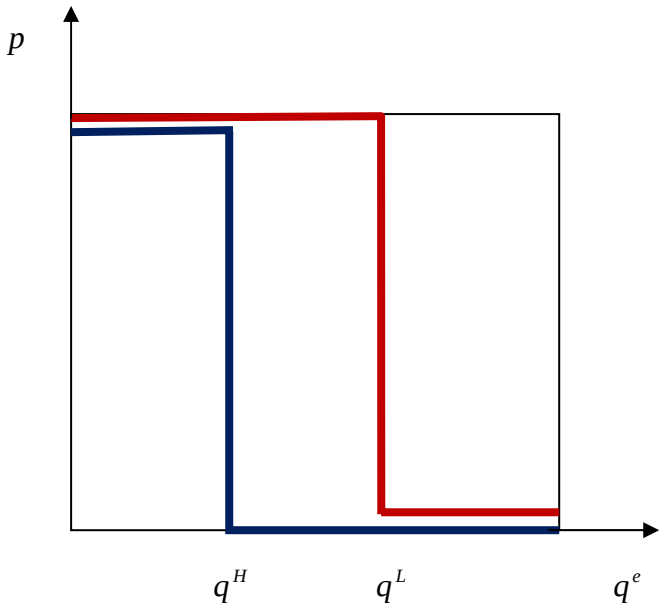
$$p_C^L = p_F^L = p_L = q_L$$

$$p_C^H = p_F^H = p_H = q_H$$

On the Figure 5, Consumers' behavior is on axis p and Firms' behavior is on the axis q. We can see, how the strategy of Consumers vary with respect to height of q. The Best Responses of High type Consumers are represented by upper line and the Best Responses of Low type Consumers are represented by bottom line. If $q^e > p^L$, the optimal strategy of Low and High type of Consumers is to Free Ride ($p = 0$). If $p^L > q^e > p^H$, High type of

Consumers will Free Ride and Low type of Consumers will play Taxes. If $q^e < p^H$, both type of Consumers will play Taxes ($p = 1$).

Figure 5: Best responses of Consumers



As already mentioned, each player has some beliefs about how probably would his opponent play Taxes and how probably would he Free Ride. Nature chooses the types with the probability $1/2$, thus each player has $1/2$ probability that his opponent is Low or High type. Therefore:

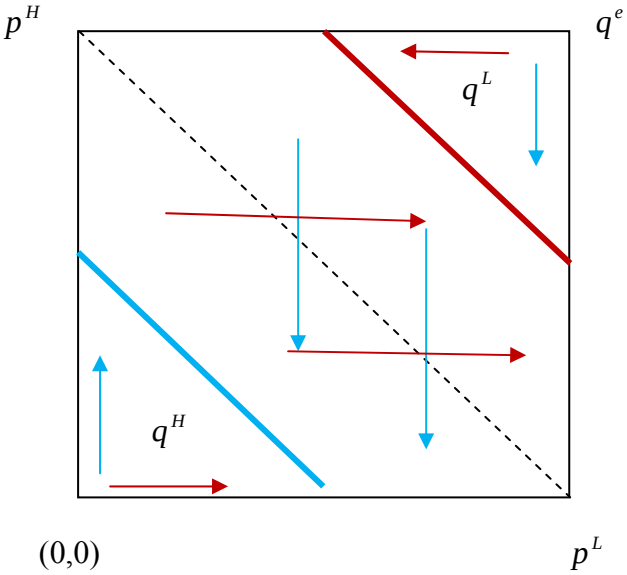
$$q^e = 1/2\, p_L + 1/2\, p_H \tag{5}$$

2.2.3 Adjustment to the equilibrium

Consumers and Firms are symmetric, therefore the adjustment process to the equilibrium will be the same for both groups. Consumers play their strategy $p \in (0,1)$ according to beliefs which they have about strategy of Firms. If Consumers believe that Firms will play taxes with very high probability, they would be well off by Free Riding, because they are sure enough that Bankruptcy will not happen. Consumers will try to adjust their strategy to the beliefs that they have about their opponent's behavior. Firms do the same and, through their beliefs about Consumers, they also adjust the probability of playing Taxes to maximize their own payoff. As both groups change the beliefs about the other group, they converge to the equilibrium. In equilibrium, each group moves only on the critical line of Low or High type of player q^L or

q^H, which represents player's Best Response on the strategy played by the other one. The process of the adjustment to the equilibrium will be shown on the Figure 4.

Figure 4: Direction of adjustment



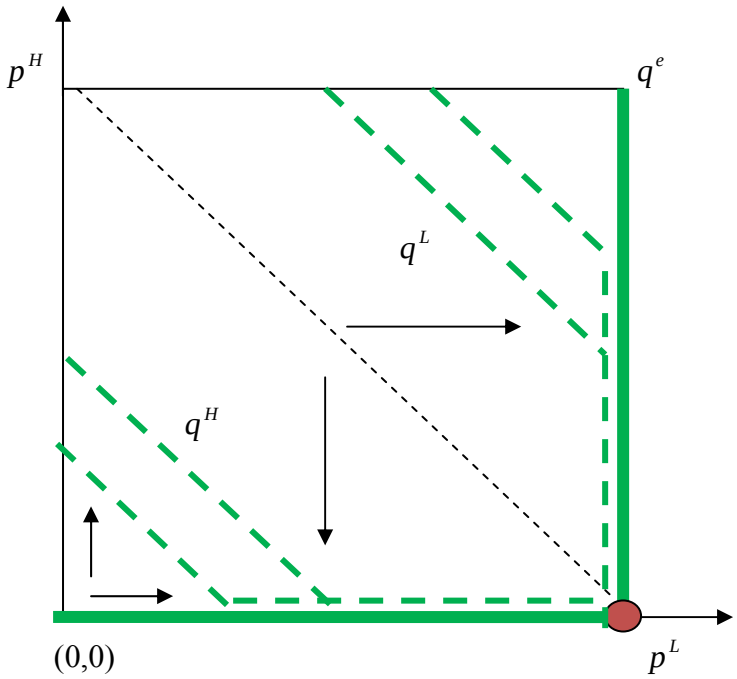
Probability that Low type of Consumers plays Taxes is represented on the horizontal axis and the probability of High type playing Taxes on vertical axis. Expected probability that the opponent, in this case - Firms, play Taxes, grows in the left-right diagonal from 0 to 1, where q^H and q^L as usually stand for critical probability level. If Firms are expected to play every time Taxes with $q^e = 1$, we are exactly in right upwards corner of the square. When $q^e = 0$, we are in downward left corner.

Again, if q^e is in the middle of the square, Consumers expect Firms to play Taxes with some positive probability. Under the direction of the arrows (vertical for High Type and horizontal for Low Type), Consumers adjust their own behavior to the lines q^H and q^L, so that their p_T is best response on the behavior of Firms. If the expected probability q^e is somewhere in between q^L and q^H, the behavior of Consumers is as follows. Low type of Consumers believes Firms to play Taxes with insufficiently low probability. Consumers thereby decide to increase their p (represented by horizontal arrows). For High type of Consumers, this probability is however high enough so they diminish their *p* and adjust in vertical direction.

As the game is symmetric, those processes happen simultaneously from Firms perspective as well. Consumers are adjusting their behavior in accord with beliefs held about the behavior of Firms, who are adjusting in the same way. Both players converge through this process to the line representing critical value q^L (if the adjuster is Low type of player) and q^H (if the adjuster is High type of player) where they are indifferent between Taxes and Free Ride.

θ is determined exogenously (randomly drawn from one distribution) so it can reach different levels, but the condition $0 < p;q < 1$ must be satisfied. There are infinitely many different costs θ, hence the lines representing q^L and q^H move upward and downwards. Two different levels of implicit costs are represented in the Figure 5 by parallel broken lines, two for each type of player. However, θ is here given, therefore, we assume its level to be fix. The position from which neither Consumers nor Firms have incentive to deviate is lying on the intersection of Low and High lines denoting Best Responses. We can see on the picture, that it is situated in down right corner, where $q^L = 1$ and $q^H = 0$. In other words, in the equilibrium Low type of the player always plays Taxes and High types Free Ride and no one has incentive to deviate (Gregor, 2009). Thus, as each player may have either Low of High utility, there are four cases of the game and there are also four equilibria, each played in one case of the game. When the players have high costs, they decide to pay Taxes with $p = 1$, while having Low costs makes them Free Ride.

Figure 5: Different welfare losses θ



To summarize this example, at the beginning of this game Nature chooses types of the players. They differ in the level of the costs which they must bear in the case of Bankruptcy. As any player does not see which type of his opponent Nature chose, Consumers and Firms have to rely only on their own beliefs about opponent's type, whereas playing with the opponent. To achieve the equilibrium, they follow the equilibrium strategies with regard to their beliefs. In such a case, where the equilibrium is determined by player's strategies and beliefs, we talk about Bayesian equilibrium.

In this section, we used the example of Bankruptcy game (version of Chicken game) to explain the principle of Mixed Strategies. Then we replaced Mixing of the players by the Nature who decides about the game being played. By leaving Mixed Strategies, players have lost uncertainty about how is the opponent playing, fortunately, they were compensated by the uncertainty with whom are they actually playing. However, we should remember that in the Mixed Strategies, players themselves can switch between strategies and beside of playing pure strategies, they can also mix and deviate. But under incomplete information, players have to play what was chosen for them and they can not deviate, because their action is given by their type.

Chapter 3

Theory: Multi-period equilibrium

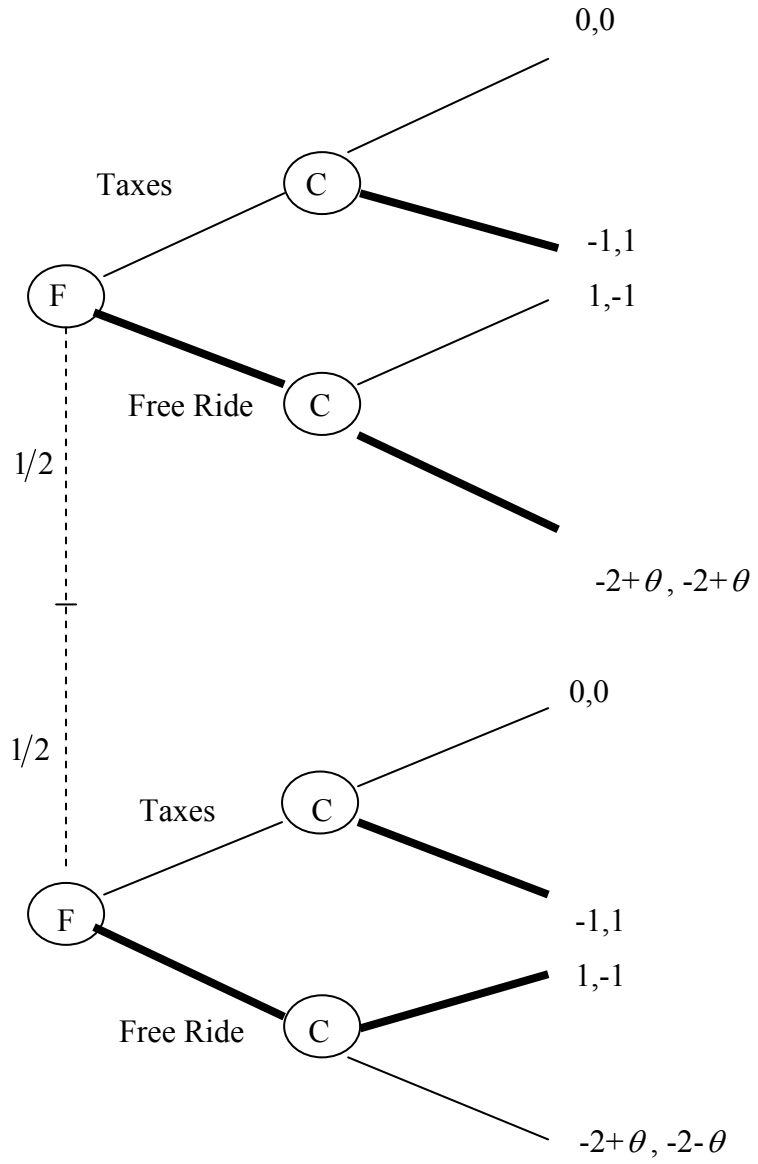
3.1 Updating beliefs

Until now, we described how players follow the equilibrium path when they do not have complete information on the opponent's payoff (costs) and when they rely on the beliefs. This concept cannot fully help us to explain the models of delayed stabilization, because time is limited to one period. If we remove this restriction and incorporate time into the model, the initial concept changes because players gradually update their beliefs in the time. Thus, a game between Consumers and Firms will look differently from what we described in previous section. Common feature is that Nature again chooses the types of players and as before the type of the opponent is unknown to each of the players. What is different, players play in the sequence, so the second player can observe the moves of the first player. Both players follow their equilibrium strategies according to the payoffs. Due to symmetry, we can describe beliefs updating only one of the two players.

3.1.1 Description of model game

We will study how Firms update their beliefs. Let us consider previous model of Consumers and Firms with some a modification in payoffs. We assume $\theta > 1$. Firms are here High player, which is common knowledge. Nature chooses with probability ½ each type of Consumers. Consumers know their own type, but Firms do not. This uncertainty is represented by the broken line between two types of Consumers – High and Low. In other word, Firms in fact do not know, in which part of the figure (High or Low) they are playing. However they may deduce it. When they finish their action, Consumers move and through their action (Taxes or Free Ride), Firms can determine their type and update the beliefs about them. The game is depicted in the Figure 6

Figure 6: Updating beliefs



3.1.2 Strategies of players

The upper part of the Figure 6 represents High type of Consumer and the under part represents Low type of Consumers. The first number in payoffs denotes the Consumers' payoff and the second number stands for payoff of Firms. By playing Taxes, Firms get the payoff π_F^T which is different from the payoff π_F^F that Firms get by playing Free Ride. However the payoffs π_F^T and π_F^F do not vary according to which type of Consumers play. By

calculating the expected payoffs of Firms from playing Taxes or Free Riding, we can say that for $\theta > 1$ they always prefer Free Ride:

$$\theta > 1$$
$$-2 + \theta < -1$$

$$\pi_F^T = \frac{1}{2}(-1-1) = -1 \tag{6}$$

$$\pi_F^F = \frac{1}{2}(-2+\theta+1) = \frac{\theta-1}{2} > 0 \tag{7}$$

Let us consider behavior of Consumers. If Consumers are High type, their Best response on any action played by Consumers is Free Ride. Knowing that Consumers have the strategy of Free Ride, Firms do not have incentive to deviate to playing Taxes, because as we showed in (6) and (7), they cannot reach higher payoff. When Consumers are Low type, and considering that Firms play again Free Ride, Consumers choose to play Taxes because it brings them higher payoff. Let us denote Consumers' payoff of playing Taxes π_C^T and Consumers'payoff of Free Riding π_C^F.

$$\pi_C^T = \frac{1}{2}(-1+0) = -\frac{1}{2} \tag{8}$$

$$\pi_C^F = \frac{1}{2}(1-2-\theta) = \frac{-1-\theta}{2} \prec -\frac{1}{2} \tag{9}$$

Since, the node succeeding the action of Firms' Taxes is never reached because Firms never play Taxes, Firms can create any beliefs about behavior of Consumers at this node. It is rational to expect that, if this node was reached (Firms played Taxes), Consumers would play Free Ride.

3.1.3 Updating beliefs process

Let us firstly describe the idea of beliefs updating. Updating beliefs means, that player, who has incomplete information, observes the movement of the opponent and, under the

assumption that he has complete information and that he maximizes his payoff, player updates his own beliefs (Rasmusen, 2007).

The probability of playing Taxes is higher for Low type of Consumers than for High type. Therefore, if Consumers do not choose to play Taxes and still respect the assumption of rationality of players, Firms have the reason to think, that Consumers are rather High than Low type. We know that the initial probability of each type being chosen is $1/2$. So ex ante, Firms know that with $1/2$ probability they play with High type of Consumers and with $1/2$ probability they play with Low type of Consumers. Then when game is started, Firms play and the action of Consumers succeed. Because High type of Consumers chooses Taxes with probability 0 and Low type chooses Taxes with probability 1, Firms can deduce the type of Consumers from their action (Gregor, 2009). And according to this deduction, they update their beliefs about type of the Consumers. Let us consider that Consumers play Taxes. Then Firms update their beliefs about Consumers being Low type from $1/2$ (prior beliefs) to 1.

During the process of updating, it is useful for Firms to know the probability that the type of Consumers is High, under the condition that Consumers played Taxes. In other words, when all past actions are taken into the account, what is the probability, that the type of Consumers is High? To calculate it, we use the formula (presented below) illustrating Bayes rule which describes beliefs update and which helps us to calculate conditional probability of High type if Consumers (Rasmusen, 2007). The probabilities for Low type are calculated in similar way.

$P(T|H)$ ...the probability that, when Consumers decide to pay Taxes, they are High type

$P(H)$ ...the probability that High type of Consumers is chosen (1/2)

$P(T)$ …the probability, that Taxes are played

$$P(H|T) = \frac{P(T|H) \times P(H)}{P(T)} = \frac{0 \times 0{,}5}{0{,}5 \times 0 + 0{,}5 \times 1} = \frac{0}{0{,}5} = 0 \tag{10}$$

$$P(H|F) = \frac{P(F|H) \times P(H)}{P(F)} = \frac{1 \times 0{,}5}{0{,}5 \times 0 + 0{,}5 \times 1} = \frac{0{,}5}{0{,}5} = 1 \tag{11}$$

3.2 Perfect Bayesian equilibrium

In previous sections, we were concerned with Bayesian equilibrium. But now we will study Perfect Bayesian equilibrium. The difference between Bayesian equilibrium and Perfect Bayesian equilibrium (PBE) is that in PBE, equilibrium has to be induced in every subgame (Peters, 2008). Thus, for Bayesian equilibrium to be perfect, both players have to behave optimally not only in the parts of the game that are played but also in the parts of the game that are never reached. In the example concerning Consumers and Firms which is extended to infinite period, perfectness means, that in every period since the beginning of the game, every player has to behave optimally given his beliefs about the behavior of the others and his own payoffs.

3.2.1 Plausible equilibrium

There exist equilibria, in which players maximize their expected payoff through their strategies and beliefs and each player behaves rationally since beginning until the game ends. Such an example was calculated in the section 3.1.2. To keep the link with reality, we will describe how this equilibrium might look in some real situation.

Consider that there is country where two political parties share the power. Each party governs for half of year (one election period) and they are switching the government, which means that one party governs in first period, the other in second, etc. Country budget suffers of excessive expenditures on healthcare, which must be cut one day. The reform is postponed by each party because if a party cuts the expenditures, it will improve the country's welfare in the long term (decades), but in the short term party will become unpopular and will not be elected again. Here, we can see the incentive for the delay of the stabilization.

You can see the parallel in fights between two dominant political parties e.g. particularly in Czech Republic – ODS and CSSD. Reform of healthcare is not the only one necessity, there are also changes of pension system, educational system, etc., which have to be done as well. Each party wants to win the elections and promises increased welfare for voters. That is realizable in short term, but to keep prosperity in longer period, the economy has to be reformed in mentioned areas. The party who finally implement the reform will be the one with higher costs in unreformed areas. However, as none of the parties know how high are the costs of the other one, the reform is implemented only after some delay, when one of the parties find it no more advantageous to delay, even though by becoming unpopular it will erase the possibility to be reelected next time. To conclude, in this example of rational

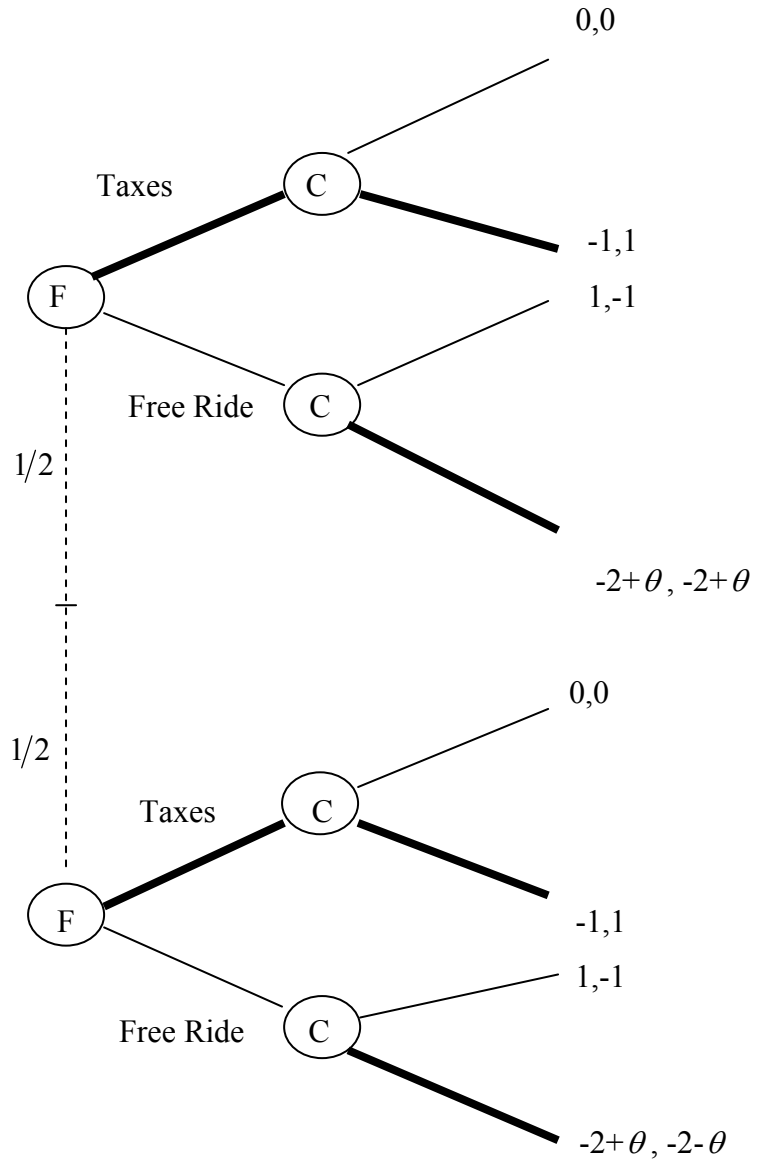
equilibrium, parties wait long enough until the one which is more vulnerable to the unreformed areas than the other one, resigns and reforms.

3.2.2 Implausible equilibrium

However, there is also implausible type of equilibrium (Rasmusen, 2007), which are not perfect. To understand what implausibility means in this context, imagine a game in which Firms (playing first) decide to follow a path which does not induce subgame perfectness, i.e. the equilibrium is not induced in every subgame.

Now, we will shortly describe the reasons which might lead to implausible equilibrium (Gregor, 2009). Imagine, that Consumers threaten to Firms, that they will always Free Ride, even if it is irrational for them. Let us change the value of θ for Firms. For now $0 < \theta < 1$. The payoffs of Firms are now different, hence under the condition that Consumers will always Free Ride, Firms prefer to play Taxes because $-1 > -2 + \theta$. Nonetheless, it is necessary to know that the threat of Consumers is in reality false. If Firms unexpectedly decided to deviate from their optimal behavior (Taxes) and played Free Ride, Consumers would not have realized their threat. However, Firms do not know this and since they are firmly convinced about the seriousness of threat, they play Taxes.

Figure 7: Implausible equilibrium



Now, we will provide this idea with some computations. Consumers may threaten Firms, that they will Free Ride either when they are High type or Low type or that they will Free Ride in any case. In order to change behavior of Firms, this threat has to cause that, the expected payoff of Firms will be lower from Free Ride than from Taxes. The expected payoff from playing Taxes is always -1, because the game is played sequentially, thereby if Firms decide to play Taxes, Consumers will always choose to Free Ride. Therefore the outcome (T,T) is never reached in equilibrium, because in such a case, each party would have incentive to deviate.

When Consumers threaten Firms with strategy (T,FR) (High type plays Taxes, Low type Free Ride) or with strategy (FR,T), the payoff of Firms from playing Taxes (RHS of

(12)) must be higher than payoffs of Firms from playing Free Ride (LHS of (12)) in order to persuade Firms to play Taxes. Since the condition $0 < \theta < 1$ is not satisfied (13), by making threat that they will play (T,FR) or (FR,T) Consumers cannot induce Firms to play Taxes.

$$\frac{1-2+\theta}{2} < -1 \tag{12}$$

$$\theta < -1 \tag{13}$$

However, Consumers may also try to threaten with strategy (FR,FR) (they decide to Free Ride in every case). Then again, to induce Firms to play Taxes, Firms' payoff has to be, under the condition that Consumers always Free Ride, higher from Taxes (RHS of (14)) than from Free Ride (LHS of (14)). As the condition $0 < \theta < 1$ is fulfilled in this case, by threatening to always Free Ride, Firms can induce Consumers to change their behavior and play Taxes.

$$\frac{-2+\theta-2+\theta}{2} = -2+\theta < -1 \tag{14}$$

$$\theta < +1 \tag{15}$$

To conclude, when they are sure that Consumers always Free Ride, Firms will find it advantageous to play Taxes. As neither group has incentive to deviate from chosen behavior, it is the Bayesian equilibrium. However, this equilibrium cannot be called Perfect Bayesian, because under subgame perfectness, Low type of Consumers should choose in the second node Taxes, which does not happen in this case.

In summary, Perfect Bayesian equilibrium requires those conditions to be satisfied (Rasmusen, 2007):

1) The strategy of player 1 for the rest (following the action played by Nature) of the game are Nash given the strategy and beliefs of player 2; same for player 2 (this condition already says, that equilibrium is induced in every subgame – even in the one which is never reached).
2) The beliefs of players are rational given that they are derived if possible from the actions already being played in the game.

Chapter 4

Models of delayed stabilizations

4.1 Introduction

Until now, we presented the theory that will be used in the model of delayed stabilization. We analyzed mixed strategies and games with beliefs, where players converge to Bayesian equilibrium. Next, we discussed beliefs updating and Perfect Bayesian equilibrium. The theory which we just presented will be used in modeling the war of attrition.

For modeling the delayed stabilization, we will firstly present model worked out by Persson and Tabellini (2002). This model covers war of attrition in two periods (only), but it will help us to explain simply how the theory of Bayesian beliefs relates to the war of attrition and how to calculate the equilibrium in the model.

Then in the second model presented by Martinelli, Escorza (2007) two periods limit will be removed and we will study the model under the assumption that interest groups may take action in infinitely many consecutive periods. But, before analyzing those models, we present some description and assumptions that are common.

4.1.1 Description of the situation

In the initial state, economy is hit by the shock, which increases public debt. To keep up with today's world, we can imagine that economy is hit by e.g. a financial crisis. Stabilization is necessary but requires a change of the policy toward several interest groups, which will be painful for them. Imagine higher regulation in companies and banks, lower wages for employees, healthcare reform including implementation of fees for visiting doctor, for buying a medication, etc. Introduced measures affect in the negative way several groups – firms, banks and also consumers and pensioners.

For stabilization to occur it is not necessary to implement every mentioned measure but it is sufficient to implement only some of them. To be precise, stabilization requires some groups to bear higher costs, while the other may avoid it and profit from stabilization's benefits. When the economy is retained in pre stabilization stage, both groups suffer some welfare loss. Banks suffer of bad mortgages and lack confidence of their customers, exporting and importing firms are affected by fluctuating exchange rates, employees by rising

unemployment rate. Those welfare costs influence the willingness of groups to stabilize and they disappear with stabilization.

As the stabilization requires some of the groups to restructure and bear higher stabilization costs (Loser) while the other might avoid it (Winner), the groups (let us say Firms and Consumers) will try to win the position of least affected group. Both groups have veto right over government decision about which group will bear high costs, therefore, government cannot intervene and choose randomly one of those groups. The stabilization occurs only when one of the groups is so much affected by its welfare losses, that it finds it better to concede than to remain in the fight.

In the model presented below, we assume that there are again two groups – Consumers and Firms – and that economy is hit by the some external shock which increases public spending. As the taxes collected from groups cannot cover it, country starts to use distortionary taxation, which consequently increases level of inflation. Stabilization is necessary but can be done only when one group decides to bear higher stabilization costs. Both Consumers and Firms naturally want the other group do perform the stabilization, thus they fight over lower share of post stabilization cost. However they can persist in fight only limited time, because they suffer from welfare costs, which were previously described by examples of fluctuating exchange rates etc. and now are related to increased inflation. Therefore, the status quo (groups do not stabilize) is unsustainable in the long term, because increased inflation affects everybody.

Stabilization can be done, only if one of the two groups agrees to bear higher portion of stabilization costs (thus accepting the position of Loser, while the other group bearing lower portion of stabilization cost becomes Winner). When stabilization takes place, the deficits stop to grow, debt is reduced and whole economy starts to recover. The crucial determinant of the stabilization time is here the behavior of two interest groups (Consumers and Firms). They maximize their overall utility and at each period (in the Model 1 it is only one period, whereas in Model 2 there are infinitely many periods) they choose either to concede (stabilize) or to continue to fight (delay).

4.1.2 Common assumptions

There are several assumptions under which the fight is conducted.

Costs

- Players suffer the costs during the fight, in our case, there are two types of costs:

1) each player has to pay explicit cost: 1/2 of the taxes ($\tau/2$) that government imposed because of stabilization delay
2) welfare loss θ_i from living in the destabilized economy (i = C,F)

- Neither of two costs develops in the time. This means that the both the size of taxes and welfare loss θ_i are determined before the fight begins.

Loss θ_i

- This is the loss from postponing the stabilization.
- At the beginning of the game, Nature randomly chooses for each player his own level of welfare loss θ_i. The cost θ_i for i = C,F is in mode 1 drawn independently from single distribution function from the interval $(\underline{\theta};\overline{\theta})$, where $\overline{\theta}$ is the upper bound and $\underline{\theta}$ is the lower bound of the possible cost level. In the model 2, θ_i may be drawn from different distribution functions. Drawing θ_i from one distribution function (model 1) does not mean that the level of costs of both groups will be the same although they might be. Imagine that θ_i is drawn from e.g. normal distribution. There is high probability (about 95%), that θ_i will fall in the interval of two standard errors around the mean value ($(\mu-2\sigma,\mu+2\sigma)$. However, in the reality, it might also happen that θ_i will fall beyond this interval, i.e. will be too low or too high.
- The distribution function of θ_i is the same for both groups and this information is common knowledge. Therefore, each player know the distribution of opponent's θ_i. Nevertheless, neither group knows the exact value of his opponent's cost. This value is known only to the opponent himself.

Action

- After the nature draws welfare cost level for each player, game starts. Although any player does not know the welfare losses of the opponent, he might have some beliefs about it and as the game proceeds and he observes opponent's behavior, he updates those beliefs. The beliefs together with his own utility function help him to create his optimal strategy.

Stabilization

- Stabilization takes place when one group (Loser) agrees to bear $\frac{\tau+\alpha}{2}$ ($\alpha\tau$ - model 2) fraction of taxes, which will be more than $1/2$ of taxes. The other group (Winner) will since that time pay smaller portion of taxes $\frac{\tau-\alpha}{2}$ ($(1-\alpha)\tau$ - model 2).
- Even though it may seem, that potential Loser has no incentive to concede, because he would be worse off paying extra amount of taxes, is it not right assumption, because after the stabilization he will not suffer welfare loss θ_i.

4.2 Model 1

4.2.1 Description

In this model (Persson, Tabellini, 2002), government collects $\bar{\tau}=\frac{\tau}{2}$ taxes per group, which are afterwards spent to keep economy running. Because the economy is destabilized, government has to spend more than the taxes collected. Beside collected taxes, government also spends amount $2\bar{b}$, which in fact measures the size of its fiscal problem. Amount $2(\bar{\tau}+\bar{b})$ is evenly spent in the first period on goods g_C^1 or g_F^1 which are consumed by Consumers and Firms respectively (16). When the stabilization is delayed, government finances both goods g_C^1 and g_F^1 from its budget (17) and g^1 states for its overall expenditure.

$$\bar{\tau}+\bar{b}=g_C^1=g_F^1 \tag{16}$$

$$g^1=g_D^1+g_R^1=2(\bar{\tau}+\bar{b}) \tag{17}$$

Each group can choose either Delay or Stabilize, so there are generally four possibilities of what might happen. Firstly, both groups decide to Delay and in the first period either of them enjoys consuming its specific good which government finances by $\bar{\tau}+\bar{b}$. As we are limited by two periods constraint, what is spend in the first period, has to be repaid in the second one. When no stabilization occurs, public debt is at the end of the first period $b_1=2\bar{b}$. The budget constraint in the second period is $2(\bar{\tau}-\bar{b})$. Therefore, in excess of taxes

$2\bar{\tau}$, Consumers and Firms have to pay $b_1 - 2\bar{\tau}$. So in total they must pay b_1 and each of them pay equal share of that amount.

It may also happen that one group decides to Stabilize in the first period. Since we have two groups in the game either Consumers or Firms can be the stabilizing group. In such a case, no debt is issued by the government $g^1 = g^2 = 2\bar{\tau}$ and government finances the goods g_C^1 and g_F^1 only from the collected taxes. But the distribution of the taxes between goods g_C^1 or g_F^1 is not even as before. The contributions are in fact lower for the stabilizing group (Loser). Therefore, by deciding to stabilize, group binds to bear higher costs of stabilization, which are represented here by decreased spending on the group's good.

Last possibility is that both groups independently decide to Stabilize. In this case, government again does not need to issue any debt $g^1 = g^2 = 2\bar{\tau}$. What is different, compared to the previous possibility is, that since the groups both stabilize, no one is Loser and thereby the distribution of the taxes between goods g_C^1 or g_F^1 is even.

4.2.2 Expected utility and strategies

According to Persson and Tabellini, we assume, that utility of group *i* (C or F) is linear in g_i^t where *t* stands for period 1,2 and that the welfare losses from inflation policy are linear in debt. Utility is not discounted in the time (Gregor, 2009). Utility function is expressed as follows:

$$U_i = W(\bar{\tau}) + g_i^1 + g_i^2 + \theta_i(\bar{b}) \tag{18}$$

We will briefly describe the elements of the equation (18). The term $W(\bar{\tau})$ is a constant, i.e. a utility from paying Taxes which does not vary in the time. Second and third term is utility from government spending on good *i* in first and second period respectively. Fourth term is welfare loss of group *i* which linearly depends on the size of public debt, therefore it can be expressed as a percent of the debt multiplied by the amount of the debt. This last term is relevant only when both groups decide in the first period to postpone the stabilization. If at least one group decides to stabilize, term $\theta_i(\bar{b})$ will be equal to zero.

All actions can take place only in the first period. We will assume that both players are risk neutral (Gregor, 2009). At the beginning, players independently decide whether to

Stabilize of Delay. Consequently, as we described above, there are four versions of what may happen. Now, we will calculate the utilities of groups for situations depicted in section 4.2.1. Firstly, both groups decide to Delay. In that case, governmental spending on each good in the first period $g_i^1(d,d)$ in the second period $g_i^2(d,d)$ and the overall utility of both groups U_i is described by (19), (20) and (21) respectively.

$$g_i^1(d,d) = \bar{\tau} + \bar{b} \tag{19}$$

$$g_i^2(d,d) = \bar{\tau} - \bar{b} \tag{20}$$

$$U_i = W(\bar{\tau}) + 2\bar{\tau} - \theta_i(b) \tag{21}$$

Secondly, it may happen that Consumers decide to Stabilize in the first period whereas Firms Delay or vice versa. Equations (22) and (23) describe the size of governmental spending over two periods on both goods $g_F^{1,2}(d,s)$ and $g_C^{1,2}(s,d)$ and consequent groups' utility over two periods. The term α is positive and measures the advantage that the Firms receive over Consumers when they decide to Delay, while Consumers Stabilize.

$$g_C^{1,2}(s,d) = \bar{\tau} - \frac{\alpha}{2} \tag{22}$$

$$g_F^{1,2}(d,s) = \bar{\tau} + \frac{\alpha}{2}$$

$$U_C = W(\bar{\tau}) + 2\bar{\tau} - \alpha \tag{23}$$

$$U_F = W(\bar{\tau}) + 2\bar{\tau} + \alpha$$

According to the original idea of war of attrition (Riley, 1980), the group which is weaker and which cannot stay in the fight since some moment, resigns and does not get the prize. In this case, weaker group is represented by Consumers who, due to high welfare losses, decide to Stabilize. Because of the symmetry, it may also happen is that Firms Stabilize whereas Consumers Delay (third version).

Finally, both groups may decide to Stabilize. In that case, stabilization takes place at the beginning of the first period and therefore government spending on each good is same for both periods and both groups as depicted in equations (24) and (25).

$$g_i^{1,2}(s,s) = \bar{\tau} \tag{24}$$

$$U_i = W(\bar{\tau}) + 2\bar{\tau} \tag{25}$$

4.2.3 Perfect Bayesian equilibrium

Now, we will describe how do groups decide whether to stabilize or not. We will describe this process of decision making on the example of Consumers (Firms behave accordingly). Each group decides on the basis of its expected payoff. Therefore, Consumers compute their expected payoff from stabilizing and from delaying and compare those values. When the expected payoff from Stabilization is higher than the one from Delaying, they choose to Stabilize (and vice versa). The expected payoff of Consumers is influenced by the behavior of Firms which relates to the level of their welfare losses. However, as Consumers are not informed about this level, they can only create some beliefs about it. Thereby, with respect to their beliefs about whether Firms Stabilize or Delay, Consumers determine their equilibrium strategy (Persson, Tabellini, 2002).

The beliefs of Consumers are as follows: P is the probability that Firms will stabilize and $P-1$ is the probability that they will Delay. Thus, the Consumers' overall expected payoff from Delay $E(U_C^{1,2}|d)$ will consist of the expected payoff conditioned by Firms' Delay and of expected payoff conditioned by Firms' Stabilizing (26). Consumers' expected payoff from Stabilizing $E(U_C^{1,2}|s)$ will be computed accordingly (27).

$$\begin{aligned} E(U_C^{1,2}|d) &= P \times (W(\bar{\tau}) + 2\bar{\tau} + \alpha) + (1-P) \times (W(\bar{\tau}) + 2\bar{\tau} - \theta_C(\bar{b})) \\ &= W(\bar{\tau}) + 2\bar{\tau} - \theta_C(\bar{b}) + P(\alpha + \theta_C(\bar{b})) \end{aligned} \tag{26}$$

$$\begin{aligned} E(U_C^{1,2}|s) &= P(W(\bar{\tau}) + 2\bar{\tau}) + (1-P)(W(\bar{\tau}) + 2\bar{\tau} - \alpha) \\ &= W(\bar{\tau}) + 2\bar{\tau} - \alpha(1-P) \end{aligned} \tag{27}$$

Now, as Consumers know their expected payoff from Stabilizing and from Delaying, they can compare them. By calculating their net gain from Delaying (28), Consumers find out whether it is for them better to Stabilize or to Delay. Then, they can decide on their strategy. Thus, if the expression on the right side of (28) is negative, Consumers choose to Stabilize in the first period, otherwise they Delay the stabilization.

$$E(U_C^{1,2}|d) - E(U_C^{1,2}|s) = -\theta_C(\bar{b}) + P(\alpha + \theta_C(\bar{b})) + \alpha(1-P) \tag{28}$$

Rearranging terms

$$E(U_C^{1,2}|d) - E(U_C^{1,2}|s) = \alpha - (1-P)\theta_C(\bar{b}) \tag{29}$$

If we look at (29), we can immediately see, that with increasing α Consumers will have tendency to Delay whereas with increasing $\theta_C(\bar{b})$ and increasing $1-P$ Consumers will have tendency to stabilize. Therefore, Consumers' strategy depends on the size of advantage α, which they may receive when they are stronger and more persistent than the opponent, on the beliefs about other group' behavior P and on their own welfare losses. Let us analyze the level of $\theta_C(\bar{b})$ at which Consumers are indifferent between Stabilizing and Delaying and let us denote this level m. At m, the net gain from delay must be equal to zero. When α and $1-P$ is given and Consumers have welfare losses above m, they Stabilize, otherwise they may Delay. With respect to (29), we calculate the level m.

$$m^C = \frac{\alpha}{(1-P)\bar{b}} \tag{30}$$

Because of the symmetry, the critical value m is same for both groups $m_F = m_C = m$. We know, that if $\theta_C(\bar{b})$ is below m, Consumers propose Delay. Thus the probability of Delay is a function of m (31). If the critical level above which Consumers must Stabilize increases, Delay becomes more probable. Thus, using (30) and (31) we can implicitly define equilibrium level of $\theta_C(\bar{b})$ (32).

$$(1-P) = \Pr ob(\theta_C(\bar{b}) < m) = F(m) \tag{31}$$

Rewriting (30)

$$m^C = \frac{\alpha}{(1-P)\bar{b}} = \frac{\alpha}{F(m)\bar{b}}$$

$$m^C \times F(m) = \frac{\alpha}{\bar{b}} \tag{32}$$

4.2.4 Probability of delay and comparative statics

As the Firms and Consumers are symmetric, the overall probability of delayed stabilization is $(1-P)\times(1-P)$. Since $(1-P) = F(m)$ and $F(m)$ is increasing in m, we can calculate the unconditional probability of observing delay (33).

$$(1-P)(1-P) = F(m(\alpha,\bar{b}))F(m(\alpha,\bar{b})) \tag{33}$$

The unconditional probability of delay is positively influenced by α and negatively by $\bar{b}$. As the utility of two groups after the stabilization diverges more (α is higher), both groups have incentive to fight longer, because if a group wins, it will get greater advantage. In the same spirit, if α is very small, groups lose their incentives to fight, because the fight itself involves welfare losses and the advantage of winning is not that great. We can also interpret α as a degree of polarization in the economy.

On the other side, if $\bar{b}$ increases, it would mean that the economy is more affected by the shock (because it needs more financial help from the government) and the delay will be shorter. This is compatible with the idea that economy would be stabilized sooner when it is hit by serious crisis.

Persson and Tabellini also mention the impact of foreign aid on the stabilization. As long as the foreign aid does not decrease value of $\bar{b}$, it helps to stabilize earlier. Foreign aid must be therefore provided under the condition stating that groups will not use it to postpone stabilization. This idea is more developed in the fifth part – Additional Determinants.

4.3 Model 2

4.3.1 Description

Now, we will present a model (Martinelli, Escorza 2007), where Consumers and Firms are infinitely lived, therefore since $t = 0$ on, they decide in every period whether to Stabilize or to Delay. Their pre stabilization costs are $C_i^D = \tau/2 + \theta_i$. The term $\tau/2$ stands for pre stabilization taxes and term θ_i stands for specific welfare (or inflation) loss. The loss θ_i is group specific and it is drawn from a distribution, which might be different for both groups. To imagine this, let us consider two different political groups, pensioners and firm owners. Each group perceives rising inflation in a different way. Pensioners are hardly affected, because they have no choice but to buy goods with increased price. Since Firms owners are often wealthy, they may escape higher inflation through buying goods abroad.

Similarly to model 1, neither Consumers not Firms are informed about welfare losses of their opponent, but each of them has beliefs about it. We assume that the beliefs of Consumers about θ_F are given by the distribution function F_F with the density f_F. Firms' beliefs are given accordingly. Densities f_F, f_C have common support $\left[\underline{\theta}, \overline{\theta}\right]$ and therefore, they are bounded from above and from below (Martinelli, Escorza, 2007).

Besides, each group has a strategy $T_i : \left[\underline{\theta}, \overline{\theta}\right] \to [0, \infty]$ through which it chooses ideal time of concession. This strategy is determined by its own welfare losses, by the beliefs about opponent's welfare losses and by the size of advantage α. For each value of θ_i, the function T_i specifies the ideal time, at which the group should stabilize if the opponent has not yet given up (Martinelli, Escorza, 2007). Groups follows equilibrium path and in every period they decide independently whether to Stabilize or to Delay.

The stabilization takes place, when at least one of the groups decides to Stabilize. The stabilizing group (Loser) will bear higher portion of new taxes $\alpha\tau$ where $\alpha \succ 1/2$. Conversely the group that Delays pays lower portion $(1-\alpha)\tau$ of new taxes. The welfare losses disappear with the stabilization. The necessary condition for observing stabilization in the finite time is that the utility of Winner and also of Loser must be always higher than their pre stabilization utility (34), i.e. that even stabilizing groups must be after the stabilization better off. This gives us the condition for θ_i (35). The relation of players' costs and utility is $C_i = -U_i$.

$$C_i^D > C_i^L > C_i^W \tag{34}$$

$$\tau/2 + \theta_i > \alpha\tau \tag{35}$$

$$\theta_i > \tau(\alpha - 1/2)$$

4.3.2 Expected utility

Let us say, that Consumers choose a time t of their stabilization. To know whether it is advantageous for them to Stabilize at t, they calculate expected utility from stabilization at t, which is composed of utility received when Firms already stabilized before t and of utility received when Firms have not stabilized yet at t. The expected utility $EU_C(t, T_F, \theta_C)$ depends on the chosen concession time t, on the strategy of its opponent T_F and on the value of welfare loss θ_C. Having the exponential function e and having also discount rate *r* such that $rx > 0$ which is satisfied always for *r* and *x* positive we can discount present value of future utility by $e^{-rx} = \frac{1}{e^{rx}} < 1$. The expected utility of Consumers is described by the equation (36) where $\nu = T(\theta_F) < t$

$$EU_C(t, T_F, \theta_C) = -\Pr(T_F(\theta_F) > t) \times \left[\int_0^t C_C^D e^{-rx} dx + \int_t^\infty C_C^L e^{-rx} dx \right] \tag{36}$$

$$- \int_\nu f_F(\theta_F) \left[\int_0^\nu C_C^D e^{-rx} dx + \int_\nu^\infty C_C^W e^{-rx} dx \right] d\theta_F$$

The first term in equation (36) expresses Consumers' lifetime utility when they are Loser. $\Pr(T_F(\theta_F) \succ t)$ describes the probability that the strategy of Firms will be to concede after t. This probability is multiplied by the lifetime utility of Consumers composed of pre stabilization utility: $-C_C^D$ and after stabilization utility: $-C_C^L$.

The second term describes the expected utility of Consumers, if Firms stabilize before t. As there are many different periods preceding t at which Firms may stabilize, Consumers may have different beliefs about stabilization time. Thus, we express the probability that Firms stabilize before t as the integral over all t satisfying the condition $T(\theta_F) < t$. The

expression in the brackets denotes Consumers' pre stabilization utility: $-C_C^D$ and after stabilization utility: $-C_C^W$.

4.3.3 Equilibrium with positive delay

Even though neither Consumers nor Firms know exact value of their opponent's welfare losses, they have some beliefs about it. According to how Firms behave as the time passes, Consumers update those beliefs. Therefore, to determine the time of stabilization we search for Perfect Bayesian equilibrium such that strategy $T_C(\theta_C)$ of Consumers is the best response on the strategy $T_F(\theta_F)$ of Firms and vice versa.

For the equilibrium $\{T_C, T_F\}$ with positive delay, we have to establish some additional assumptions which will help us afterwards to compute the equilibrium (Martinelli, Escorza, 2007). For $i = C, F$, the assumptions are:

1) There exists $m_i \in [\underline{\theta}, \overline{\theta}]$ such that ideal time of concession $T_i(\theta_i) = 0$ on the interval $[m_i, \overline{\theta}]$; in other words, since certain level of welfare cost, Consumers will prefer to stabilize immediately. The proxy of this situation might be hyperinflation in Germany in twenties of 20th century, which was 29000 %. Under such level political parties decided to stabilize immediately.
2) $T_i(\theta_i)$ is strictly decreasing in $(\widetilde{\theta}_i, m_i]$ for some $\widetilde{\theta}_i \in [\underline{\theta}, \overline{\theta}]$ such that $\min\{\widetilde{\theta}_i, \widetilde{\theta}_i\} = \underline{\theta}$ and $T(\widetilde{\theta}_C) = T(\widetilde{\theta}_F) = \overline{T}$ for $\overline{T} > 0$

We also establish for $T_i(\theta_i)$ the inverse function $\phi_i(t)$

$$\phi_i(t) = \begin{cases} T_i^{-1}(t) & 0 \prec t \prec \overline{T} \\ \min_{\theta i} T_i^{-1}(0) & t = 0 \end{cases} \tag{37}$$

The value of $T_i(\theta_i)$ is decreasing in θ_i, which could be explained in the way that, if welfare losses from pre stabilization distortions increase, Consumers are more willing to stabilize earlier, therefore the $T_i(\theta_i)$ decreases. On the contrary, as the function $\phi_i(t)$ depends

inversely on the planned stabilization time t, when θ_i rises, ideal time of stabilization decreases and $\phi_i(t)$ will go up. Same holds for Firms as well.

Now, we have established necessary assumptions and the function $\phi_i(t)$, we can determine the equilibrium. We will again consider the perspective of Consumers. The expected utility is maximized in the equilibrium, whereas outside the equilibrium it is not, therefore, when player is outside of the equilibrium he has incentive to deviate. To find out the higher expected lifetime utility, Consumers have to calculate their expected utility in every period from time $t = 0$ on, then compare $EU_C^1, EU_C^2, EU_C^3, ..., EU_C^\infty$ and choose the highest one. Since such a comparison would be almost impossible to made, we will use another method to calculate the highest expected utility. Since the function $EU_C(t, T_F, \theta_C)$ is continuous, we will differentiate it by *x* a put it equal to zero in order to find specific time *t*, where the function $EU_C(t, T_F, \theta_C)$ attains its maximal value. We receive:

$$\left[-\frac{f_F(\phi_F(t))\phi_F'(t)}{F_F(\phi_F(t))} \right] \times \frac{2(\alpha - 1/2)\tau}{r} = \phi_C - (\alpha - 1/2)\tau \tag{38}$$

$$\underline{\theta} \prec \min\{\phi_C(t), \phi_F(t)\} \leq \bar{\theta} \tag{39}$$
$$\underline{\theta} \prec \min\{\phi_C(t), \phi_F(t)\} \leq \bar{\theta}$$

The LHS of the equation (38) expresses the conditional probability that Firms Stabilize at time *t* multiplied by the expected gain that Consumers receive by waiting another instant to Stabilize, ($C_C^L - C_C^W \rightarrow \alpha\tau - (1-\alpha)\tau \rightarrow (2\alpha - 1)\tau$). The RHS of the equation is the cost of waiting another instant to concede ($C_C^D - C_C^L$).

Now, we will describe the process of updating beliefs with respect to (38) and (39). Let us say, that Consumers have $\theta_C < \bar{\theta}$. At $t = 0$ (before the game starts) there is some probability, that Firms have welfare losses $\theta_F = \bar{\theta}$ and that they will tend to stabilize immediately. If Firms do not concede at $t = 0$, Consumers know with certainty, that Firms do not have welfare losses $\theta_F = \bar{\theta}$ and they update their beliefs about the Firms' welfare losses. As the time passes and Firms are not stabilizing, Consumers are in every period updating their beliefs and learn more about their opponent's cost distribution.

The equation (38) describes the equilibrium where the marginal gain from stabilizing equals marginal loss from stabilizing. Assuming that both groups behave rationally, and they update their beliefs according to what happened in the past, for each value of welfare losses θ_C, θ_F randomly drawn from one distribution and for according beliefs, there is one equilibrium, which is Bayesian Perfect.

4.3.4 Equilibrium without delay

The condition (39) establishes, that no group concedes at $t = 0$ with probability 1 and at least one of the groups concede at $t = 0$ with positive probability (Martinelli, Escorza, 2007). Then, beside there are many equilibria without delay and which are not subgame perfect. In those equilibria, one group stabilizes at time $t = 0$ and the other group concedes after time long enough to deter first group from deviating. In this case, the situation is the same as described by implausible Bayesian equilibrium in the section 3.2.2.

Let us say, that Firms will persuade Consumers about their commitment to concede in the equilibrium only after some delay long enough. Firms' ideal stabilization time must fulfill the condition that it is always higher than the stabilization time of Consumers. Even though this commitment might seem irrational to Consumers, they will not expect Firms to deviate from chosen strategy. Thus, by knowing that Firms stabilize only after time long enough, the best action that Consumers might take is stabilization at $t = 0$. According to (35), Consumers will always be better off by immediate stabilizing than by delaying. Thus, in the equilibrium, Consumers stabilize immediately and Firms delay long enough in order to deter the first from deviating. There is in fact not single Bayesian equilibrium but many Bayesian equilibria with positive delay. Consumers' beliefs concerning stabilization time of Firms are different in each of those equilibria.

Such a commitment to never concede could have been seen in Latin America in 80s, when conservative government appointed sometimes ministers with long carrier abroad, who were supposed to be insensitive to domestic problem (Martinelli, Escorza, 2007). Commitment to never concede can be also seen among the governments (Martinelli, Escorza, 2007) that are obsessed with their ideology principles and that are not believed to ever renounce on them. We saw that e.g. among communist parties in 20th century or in 1930s in Nazi Germany.

4.3.5 Comparative statics

For studying comparative statics, we are interested only in the unique Perfect Bayesian equilibrium. Thus, we will suppose that there exist some arbitrarily small probability $p_i\varepsilon$ that the groups will never concede and we will modify the original model. After this idea is incorporated in the model, we will be left only with the unique Perfect Bayesian equilibrium, on which we are able to study comparative statics. We again describe the conditions and the equilibrium from Consumers' perspective. To adapt the model, we will add following assumptions (Martinelli, Escorza, 2007).

Assumptions:

1) The distribution of costs *F* will be modified in following pattern:

$$\begin{aligned} G_C(x) &= F_C(x)(1-p_C\varepsilon)+p_C\varepsilon \\ g_C(x) &= (1-p_C\varepsilon)\,f_C(x) \end{aligned} \tag{40}$$

2) With respect to Martinelli and Escorza, let also be:

$$Kc = (\underline{\theta} - 1(\alpha - 1/2)\tau)\ln(p_F/p_C) + \int_{\underline{\theta}}^{\bar{\theta}} \ln(G_F(x)/G_C(x))dx \tag{41}$$

When we have $p_C, p_F > 0$, the equilibrium is given by:

$$\int_{\phi(0)C}^{\bar{\theta}} (g_C(x)/G_C(x))(x-(\alpha-1/2)\tau)dx = K_C \tag{42}$$

3) In order to replace functions $G_C(x), G_F(x)$ by original functions $F_C(x), F_F(x)$, we will further assume, that when $\lim\varepsilon \to 0$ it holds that:

$$\int_{\underline{\theta}}^{\bar{\theta}} \ln\left(\frac{G_C(x)}{G_F(x)}\right)dx = \int_{\underline{\theta}}^{\bar{\theta}} \ln\left(\frac{F_C(x)}{F_F(x)}\right)dx \tag{43}$$

In words, the distribution of costs *G* converges to distribution *F*.

4) $\phi_C(0) < \overline{\theta}$ if and only if $\int_{\underline{\theta}}^{\overline{\theta}} \ln\left(\frac{F_F(x)}{F_C(x)}\right)dx > 0$; then, the commitment-proof equilibrium (Martinelli, Escorza, 2007) is given by:

$$\int_{\phi(0)C}^{\overline{\theta}} \frac{f_C(x)}{F_C(x)}\left(x-(\alpha-1/2)\tau\right)dx = \int_{\underline{\theta}}^{\overline{\theta}} \ln\frac{F_F(x)}{F_C(x)}dx \tag{44}$$

We will now investigate the probability of immediate stabilization changes with respect to different factors. The probability of immediate stabilization is described by $\phi_C(0)$. $\phi_C(0)$ is inverse function to the best strategy $T_C(\theta_C)$, which can be described as the ideal time of concession. Hence, when a group will prefer to concede early ($T_C(\theta_C)$ is low), $\phi_C(0)$ will be high (Martinelli, Escorza, 2007).

Now, we will describe how the change in α affect the probability of immediate stabilization. Assumed that distribution of costs do not change, if α increases (i.e. the RHS of the equation decrease) $\phi_i(0)$ must decrease in order to keep the equality of the equation. As α stands for higher polarization in the society, we can say that with higher polarization immediate agreement should be more probable. In other words, under wide distribution of adjustment costs, i.e. when one party has to pay a lot and the other one a little, it is more probable that they will stabilize without a fight, which Martinelli and Escorza find as a surprising result. However, when they decide to enter into the fight, the delay would be higher under high polarization than under the low one, which is already mentioned in comparative statics of model 1.

Next, we will describe the effect that has divergence and convergence in the amounts of welfare losses. Suppose that $F_C(x) \succ F_F(x)$, i.e. Firms have for all values of $F_F(x)$ lower welfare losses than Consumers. Then, if the $F_F(x)$ decreases even more, the probability of immediate agreement increases (because of upward shift of $\phi_i(0)$). Intuitively, when the inflation losses of the parties are very different, potential Loser knows that his chances to win are small and he is willing to concede earlier with higher probability. Conversely, if $F_F(x)$ is very small and increases, i.e. the fight becomes tight, it is less probable that one fighter will give up his chances to win and concede before fight.

Finally, we will describe the effect of increase of welfare losses $F_C(x), F_F(x)$. If the inflation costs become proportionally more painful for both parties, $\phi_i(0)$ shifts upwards, i.e. probability of immediate agreement increases. When both parties suffer more because of pre stabilization losses, the probability that one of them stabilizes at $t = 0$ is higher.

Chapter 5

Additional determinants

5.1 Introduction

In the previous part we modeled delayed stabilization with use of Bayesian beliefs theory together with beliefs updating. We reasoned the delay in the stabilization by the fight between interest groups in which each group tries to avoid pains of stabilization and transfer it onto the others (Alesina, Drazen, 1991).

Firstly, we discussed model (Persson, Tabellini, 2002) in which groups independently decide whether to delay a reform for one period or not. In the second model (Martinelli, Escorza, 2007), groups had the possibility to stabilize in infinitely long period.

We discovered that the magnitude of the delay is influenced by several important factors in the first place. The changes in the distribution of inflation costs of one or both groups have definitely impact on the delay. If both parties suffer more of the inflation, they would accelerate the reform, on the other hand when the costs of one party only increase or decrease, the final effect on delay is not so straightforward. We saw that polarization of the society also affect the delay and the probability of immediate agreement.

5.1.2 Rationale for war of attrition model

Our thesis is concerned with the question why countries do not stabilize when inflation is very high and why they instead tend to delay. We reasoned this behavior by the fight of two parties in power modeled as a war of attrition.

But, to be fair-minded, we must admit that the highest hyperinflation that ever were – e.g. nowadays in Zimbabwe or in Serbia took place under purely dictatorial regimes and hence cannot be reasoned by any conflict of interest groups. Let us describe more in detail the case of Zimbabwe. President Mugabe, who is maintaining power in the country since 1980, resolved country's problems through unsustainable politics of money printing. Zimbabwe changed in recent 30 years from exporter of agricultural products to net importer. It is important to say, that a restructure would not be that easy today, because the unemployment here is around 90% and the economy is completely destroyed. In April 2009, as a consequence of the hyperinflation that reached 230 mil percent, the national currency -

Zimbabwean dollar - was abolished. There are other well know examples of hyperinflation. One of them is Serbia in 1990s under the president Milosevic.

As we can see in those particular cases, the source of problems is absolutely different from the one that we proposed above (Yilmaz, 2001). According to our model, inflation (which is represented by delayed stabilization) is a result of disagreement between two interest groups sharing the executive power (Alesina, Drazen, 1991). But we can clearly see that countries, where highest inflation took place, had authoritarian government regime. This evidence, at first glance, reduces the reliability of our model. Hence, we will now show that the existence of hyper inflation in dictatorial regimes does not undermine the efficiency of war of attrition model.

There exists evidence that especially nondemocratic regimes are crucial for rapid growth of inflation, whereas democratic regimes with at least two arguing parties, even though incompetent to stabilize quickly, are able to deal efficiently with the threat of hyperinflation. According to Aisen and Veiga (2007) higher polarization, less democracy, lower institutional quality represented by lower degree of Central Bank independence lead often to volatile and high inflation. In addition, under less democratic regimes where Central Bank lacks independence in decision making, political instability induces very high levels of inflation, while in democratic regimes with independent Central Bank, political instability was not found to affect inflation volatility.

This issue is investigated also by Yilmaz who explains inflation in nondemocratic countries as a result of existence of political elites. Political elites use to finance from governmental resources their own interest activities. Therefore, as they are not willing to limit their personal activities, they are not successful in implementing tight measures. Besides, they want the keep the favor of people, which is realized through heightened public spending on social contribution, unemployment benefits etc. Thereby, they are also not able to increase revenues through taxes.

As was shown, the existence of hyperinflations in nondemocratic regimes can be very well reasoned and does not deny the effect of war of attrition in delayed stabilization.
Basically, it helps us to understand how necessary the existence of democracy is for stabilization (though delayed).

5.1.3 Structure

For now, as we justified our application of war of attrition model on delay stabilization, we will determine how the additional chosen factors further influence the delay. Firstly, we will study the impact of crisis on the expected delay. Next, we will continue to discuss whether foreign aid precipitates or postpones the stabilization time. Thirdly, we will investigate the influence of external intervention by the government. According to empirical evidence, many parties stabilize at the beginning of the election period. We will discuss possible reasons for this behavior. Further, we will study impact which has ideological orientation of parties. We will conclude by describing the impact which may have cohesion within parties.

5.2 Effect of crisis

In this part, we will examine the effect of crisis on the stabilization delay. Firstly, we will investigate the effect of increased inflation losses on delay in non-cooperative framework of war of attrition and secondly in the framework where parties can communicate and bargain about the prize. As not every crisis appears in the form of increased inflation losses, we will explore the effects of political crisis on stabilization delay.

5.2.1 Increased losses: War of attrition

Symmetric costs of inflation

The effect of crisis can be interpreted as increased inflation costs or increased debt and can already be included either in model 1 and 2. Higher inflation costs have in majority of cases impact on groups and economy will be stabilized earlier, because the payoffs of the groups decrease. In the models, the inflation is represented by welfare losses θ.

That the crisis has positive influence on the time of stabilization, was empirically proven by many authors. Veiga (2008) and Alesina et al.(2006) both found out, that stabilizations occurs more likely during the crisis than in calm periods. Other examples, on which we can well illustrate efficiency of crisis for the stabilization, is Germany and France in twenties of 20^{th} century (Hsieh, 2000). The inflation in Germany reached 29000 % in 1923 and this level forced the political parties to agree and stabilize. Similarly, France had to experience after First World War numerous speculations against franc until the stabilization was undertaken.

Asymmetric costs of inflation

While talking about crisis we have to remember, that it does not affect everybody in the same way and degree. Also inflation costs, that represent a proxy of crisis, do not increase for all parties by same percent (Hsieh, 2000). In reality, inflation is biased, so there are groups more and less affected by it. To illustrate this bias, it may happen, that government does not weight the welfare of two groups equally and as a response to tougher crisis, it raises the distortionary taxes for one group more than for the other one. Let us consider the example when government decides to raise corporation taxes, personal taxes leaves on the pre crisis level and increases social benefits. Such a government would probably support left-wing or centered groups, definitely not extreme right. Therefore, as right wing party in the War of Attrition model will be more affected by the crisis, it will be also more willing to resign sooner.

To model this situation, we have to use different distributions of costs for both parties. This topic is discussed by Martinelli and Escorza. According to them, the impact of uneven crisis on the stabilization time depends on whether the party most affected by the crisis is the one with higher or lower adjustment costs. When crisis reduces welfare of party with low inflation costs, the delay may even extend, because the forces of two fighters become more equal.

5.2.2 Increased losses: Alternating offers

Model: Alternating offers over infinite time

Until now, we analyzed the speed of stabilization under the condition that the parties act independently and cannot communicate. But in reality, parties bargain quite frequently, therefore we will describe it more in detail. To explain it, we will use the model of alternating offers described by Persson and Tabellini (2002). There are again two parties, Consumers and Firms who alternate in offering different shares of one prize one to each other. With time passing the value of prize is discounted and each group uses different discount factor δ_C and δ_F.

The necessity for two different discount factors can be explained on the example of two groups – Consumers and Firms, who fight over higher wage. Consumers are sure that after some time, they win. But until then, they must survive with low wage and in addition bear the costs of fight. Knowing that they keep alive during this period, it is rationale to wait ad win. Firms face similar decision problem. But the difference between those two groups is, that Consumers put at stake their personal human existence, whereas Firms are only legal

entities, so in the worst scenario they can bankrupt, which is not as big catastrophe as death is. Second difference is that banks grant the loan rather to firms than to individuals because firms can guarantee the repayment of loan by future profits. Conversely, the thrust of banks into Consumers has limits therefore they cannot take any loan for granted. As Consumers are limited to shift their spending between periods, their ability to persist long fight is limited hence we have different discount factors (Gregor, 2009).

As explained, groups alternate in offering shares of prize, which may be represented by lower share of adjustment costs. We will denote M the maximal non discounted share of prize that Consumers can obtain. Consumers give the first offer of $1-M$ to Firms while keeping M amount of the prize. Firms may accept or reject this offer, so this process may extend over infinite time and it finishes only when Consumers receive M.

As they know that M is maximal possible value that they can receive, it is unlikely that they would accept something lower than M**.** Now, we are concerned about computing equilibrium value of M, which Consumers finally receive and which depends on the discount factor. To do so, we will calculate the share which is offered in two preceding periods ($t-1$, $t-2$). In $t-1$, to have some hope of being accepted, Firms have to offer share no lower than M. Because of discounting, we know that share at t=0 is already discounted, therefore, Firms offer instead of M only $\delta_C M$ while keeping $1-\delta_C M$. The same holds for period $t-2$. Consumers know, that Firms are not willing to accept anything lower than $1-\delta_C M$ from period $t-1$. As this value is into the past again discounted, Consumers offer $\delta_F(1-\delta_C M)$ and keep $1-\delta_F(1-\delta_C M)$. To summarize it, we have:

Time	Consumers	Firms
$t-2$	$1-\delta_F(1-\delta_C M)$	$\delta_F(1-\delta_C M)$
$t-1$	$\delta_C M$	$1-\delta_C M$
t	M	$1-M$

To receive equilibrium value of M which depends on discount factor, we put $t-2=t$:

$$1-\delta_F(1-\delta_C M)=M \quad \text{or} \quad \delta_F(1-\delta_C M)=1-M$$

Rearranged

$$M = \frac{1-\delta_F}{1-\delta_C\delta_F} \tag{45}$$

For $\delta_C = \delta_F = \delta$ we have

$$M = \frac{1-\delta}{1-\delta^2} = \frac{1-\delta}{(1-\delta)(1+\delta)} = \frac{1}{(1+\delta)} \tag{46}$$

Influence of crisis

Therefore, as we can see, the offered share $1-M$ depends on the discount factor and thus on the rate of discounting. According to $\delta = \frac{1}{1+r}$, if the rate of discounting is very high ($r \to \infty$) and the prize loses majority of its value in the second period ($\delta \to 0$), almost any offer will be accepted immediately. With respect to (46) Consumers can get in such a situation any share of the prize they want, because their proposal will be accepted every time. High discount rate is a representative of crisis and, similarly to models without bargaining, it forces fighters to stabilize sooner because the costs of delaying are very high. Not surprisingly Consumers are under those conditions tempted to offer Firms very large share, because they know that Firms cannot refuse (Hsieh, 2000).

Oppositely, when the discount rate is very low, i.e. there is mild or even any crisis, the proposal of Consumers must be close or equal to 0,5 in order to be accepted. Therefore, with low discount rate, accepting party is not forced by time and can accept only offers sufficiently high. Having this option is possible source of delay.

5.2.3 Political crisis

Nevertheless, crisis may have beside increased inflation also other reasons. It appears when a country is politically instable, e.g. there are many disputing political parties or there are only few of them or even single party which is not able to govern. To support this idea by recent example, we can imagine nowadays situation on ČR political scene, when we have caretaker government with ultimate elections planned for autumn. Another example is of political instability in recent time is Ukraine or Georgia. Situation in those countries can definitely be

called crisis. Now, we will study the effect of political instability or crisis on the stabilization delay.

Political instability and consequent economic problems can be caused by uncertainty of parties about the future (Bussiere, Mulder, 2000). Such an uncertainty appears e.g. during elections, in which, despite existence of polls providing important source of information, people do not know the results ex ante. As a consequence of uncertainty, stabilizations are often postponed to post election periods. We can illustrate this on the example of Mexico, where, during every presidential election since 1982, uncertainty about future was very high. As a consequence, the sensitivity to financial pressures increased and each time lead to substantial economic crisis.

As already denoted earlier, countries with high degree of polarization are believed to delay stabilization. This finding is supported (Persson and Tabellini) in model 1, where the degree of polarization is represented by α . Veiga (2008) also explores the impact of political variables on stabilization delay. He finds out that parties fractionalization and more governmental crises in the past positively influence delay of reform. This is consistent with our proposal, that not only inflation but also political crises and instabilities prevent successful implementation of the reforms.

In addition, according to findings made by Veiga (2008), less freedom and pluralism induce successful implementation of the reform, which suggests that authoritarian regimes are more capable to implement unpopular reforms. This result is in contrast with findings that especially countries with nondemocratic regimes suffer unusually high inflation, which is in fact consequence of executive's tendency to postpone stabilization. This ambiguity may have simple explanation. Primarily, it is not likely, that authoritarian regimes will start to implement reform which weakens their authority or reduces the financial sources that they use for private purposes. But when they decide to stabilize, it is probable that the stabilization will be successful, because they face less executive constraints than e.g. in democratic regimes. Finally, we can conclude, that that inflation crisis has positive effect on the time of stabilization. However, when the crisis has political nature, its contribution to earlier stabilization is negative.

5.3 Foreign aid

It may be clear, that when two interest groups fight over smaller adjustment costs in a destabilized country, foreign aid will definitely influence their behavior. Above all, to

understand, why the aid is offered by foreign states, we need to keep in mind that countries are interconnected in variety of areas, which means that disturbance in one country may negatively and very quickly affect other states as well, all the more when a country is large (Pugel, 2004). To prevent potential crisis from spread, foreign states decide to help country in need.

Despite positive intentions, foreign aid can influence time of the stabilization in positive but also in negative way. As Dani Rodrik (1996) argues by example of Turkey in 1980s, under the guarantee and provision of foreign resources, the government did not perceive reform to be so necessary and it lost the possibility to perform harmless stabilization. The examples supporting severe crisis as an accelerator of the reform rather than foreign aid are successful stabilizations made in South Korea and Taiwan in 50s (Haggart, Kaufman, 1992). Those countries decided to stabilize only after it was evident that United States would not provide them with a further financial help.

5.3.1 Moral hazard

Though intention is clear, the final effect of foreign aid on stabilization time is ambiguous. Naturally, when foreigners grant the aid unconditionally, receivers can be driven by moral hazard and waste the aid or even use it to resist the adjustment longer (Casella, Eichengreen, 1994)

According to Svensson (2000), when a government asks for the aid to improves social condition of poor, and the aid is furnished, the recipient cares not only about the welfare of poor but he also pursue his own goals. Svensson points out that foreign aid in many cases did not enhance growth, neither it diminished poverty as indicated by human indicators for development. He denotes that one possible reason, why foreign aid has small or even no effect on policy and institutions of recipient countries, is moral hazard from the part of recipient country.

It is indeed very difficult to diminish moral hazard. However, it can be reduced when the aid is provided conditionally. Thus, although moral hazard is an important driver, there exist also cases, when foreign aid made stabilization efforts successful. To give an example, the help provided after 2nd World War by Marshall plan, eased renewal of France and Italy destroyed by the conflict. According to Casella and Eichengreen (1994), it helped to avoid potential tension between labor and capitalists.

Obviously, social tension is reduced only if the aid is divided between interest groups ex ante, (e.g. already by the foreign provider or by the government) when interest groups have not possibility to influence the division and therefore they neither have the incentive to fight over it. When fighting groups influence spending of foreign aid, it is likely that the tension will even increase and fight will get harder.

5.3.2 Channels

Another determinant influencing effectiveness of the foreign aid is the channels through which it is provided. On the one side, aid directly invested into particular department cannot be wasted or abused that easily. On the other side, foreign government knows receiver's problematic areas only partially and risks that it will choose to support wrong (undamaged) one. Contrary to this, if receiving country determines the spending of aid, moral hazard may appear more probably, however, home government has otherwise potential to use the aid efficiently (Baldwin, Wyplosz, 2006).

5.3.3 "Aid with delay" model

Description of model and assumptions

Cassela and Eichengreen (1994) model the impact of the foreign aid, implementing the assumption that there exists a time gap between announcement of the aid and its delivery. This gap can include agreement of several control bodies and foreign authority, administration, etc. Due to this, the transfer has two effects on the concession. Firstly, it reduces the overall fiscal burden of Loser. On the other side, it increases his marginal benefit from postponing the stabilization to the time when aid is already available. If Loser stabilizes before the aid arrives, he has to pay original taxes until the aid is disbursed. Another assumption of this model is that the aid is not extended instantaneously upon advent of inflationary pressures". Thus the aid is furnished from time t on and cannot be used to cover only future expenses.

High/Low cost player

According to Casella and Eichengreen (1994), the effect of foreign aid on stabilization delay depends on the height of individual inflation costs. The potential Loser party is encouraged to early concession, when the foreign aid is announced, because it might have to finance larger

share of debt after stabilization. Since foreign aid reduces the lifetime loss of potential Loser, he will be more prepared to concede.

However, since there is a delay between announcement and provision of the foreign aid, groups have incentive to postpone stabilization until the foreign aid arrives. This has simple reason. If a group concedes right after the aid announcement, it has to pay original amount of taxes, up to the provision of the aid. This makes the group to delay its concession. The relative importance of the two effects – conceding and delaying – depends especially on the on the size of welfare losses. If this is too high, groups resist the temptation of waiting until the aid arrives and stabilize soon. Otherwise, they delay.

What is also essential according to Cassela and Eichengreen (1994), is proper timing. If the gap between announcement of the aid and its delivery is not too large, potential Loser does not have incentive to postpone his concession.

Advice for foreign policy

In summary, it is counterproductive to offer the aid in the late phase of the fight. When the game is already running some time without concession, it is evident that both players have probably low inflation costs. It is naturally believed that, when they were able to fight so long, they would be able to keep in fighting for some more time. Thus, if they are offered foreign aid in the late phase of fight, it would be advantageous for them to wait with concession one more moment – until the aid arrives, because all their future taxes would be lowered by the foreign aid.

When there are players with high inflation costs and the aid is announced early, it has positive influence on concession of the players. As high cost players suffer significantly of welfare losses and foreign aid reduced the lifetime costs of conceding, they might be influenced to concede earlier.

However, we cannot automatically expect that there are some high costs players who will be induced by the provision of foreign aid to concede earlier. Player's costs are not known ex ante and only in the late phase of fight it is evident that the players have low costs of inflation. On the other side, in the early phase of the fight there exists a positive probability that at least one player has high costs. Therefore, if the aid must be granted, it is more advisable to provide it only in the early phase of stabilization.

To conclude, as we saw, there are several aspects which have to be considered when we talk about efficiency of foreign aid. It is agreed not only by Cassela a Eichengreen (1994)

but also by Alesina (2006) that the evidence that foreign aid provides incentives to stabilize earlier is quite mixed.

5.4. External intervention

There might appear another factor influencing the behavior of fighting interest groups. It is a governmental intervention (Alesina, Drazen, 1991). Government wants speed up the stabilization and gives fighting groups a warning. If groups do not stabilize until time T, government will cut majority of expenditures, combine it with taxes increase and every party will be even worse off than potential Loser. Denote θ^* the loss which induces concession at T under original conditions. If there is a party that has loss $\theta < \theta^*$, it will rather concede at T than wait for government intervention and concede afterwards as Alesina and Drazen point out, the distribution of concession times will have, under those conditions, mass point at T in the case that the players have not conceded before T. If both parties concede at T the coin is flipped and Winner or Loser is chosen with probability $1/2$. .

This implies a negative side of governmental intervention – those, who have costs $\tilde{\theta}$ close but above θ^* and who intended to concede under original conditions before T, will find it now advantageous to wait until T. This is because, right before T, potential Loser would have conceded with probability higher than $1/2$ whereas at T, he has still $1/2$ chance to become a Winner. This in fact delays stabilization. The optimal strategy of groups having costs higher than $\tilde{\theta}$ will not be affected.

With respect to the model of Alesina and Drazen, if the income of the parties will be very large, the gap formed by $\tilde{\theta}$ and θ^*, where players are indifferent between concession and waiting until T, will get larger. In such a case, the concession will occur more probably at T. When the parties have losses between $\tilde{\theta}$ and θ^* the intervention is not beneficial, because it postpones concession time until when it is unavoidable.

But it is necessary to remember, that we base our model on the assumption, which might not hold in reality e.g. that parties expect to be better off after stabilization, because the discomfort incurred by welfare losses disappears. In reality, party in pre stabilization period might not be forced to concede in a finite horizon. Real interest groups may learn in time, how to reduce the welfare losses. After becoming better off than potential Loser, they will maintain status quo forever. Therefore, when fighting groups are able to internalize their

welfare losses, external threats are necessary for stabilization to happen. Hence, it cannot be denied, that those interventions are in reality quite useful.

5.5 Electoral cycle

Alesina et al. (2006) mention, that stabilization often takes place after political consolidation – i.e. at the beginning of the electoral cycle. This can be explained by three different hypotheses, which are presented below.

5.5.1 Political business cycle hypothesis

Firstly, according to political business cycle hypothesis, it is believed that politicians increase public spending before the elections to attract voters by campaigns or to "buy" them by welfare politics. Increase in deficits obviously suggests that stabilization does not happen. For first glance, it may seem as a straightforward tool to increase chances in elections. It is though questionable whether voter's orientation and final party preference is influenced by pre election behavior and promises of politicians. It was empirically found (Brender, Drazen, 2005) that pre electoral deficits made by a party do not ensure its reelection. Therefore, even though this tool is generally known and used, its effect is perhaps not that big as envisaged. With respect to this Brender and Drazen (2005) found out, even though the idea of political business cycle seems natural, this phenomenon was detected only in some countries and it is less spread than the perception of it.

5.5.2 War of attrition

The idea, that stabilization takes place after elections, can be explained also differently. According to War of attrition model, concession does not occur before elections, because parties in fight are not sure about the costs of their opponent. Knowing that they will discover them soon, concession is meaningless for them and they prefer to wait until relative positions are uncovered (Alesina et al., 2006). Conversely, as the positions are revealed after the elections, weaker candidate has no reason to continue in fighting because he knows that winning is impossible. Besides, remaining in fight can bring him only more welfare losses. Consequently, stronger candidate gets the power which enables him to perform stabilization in the way he likes.

5.5.3 Fear of raising the issue

Howitt and Wintrobe (1995) also analyse the possibility that stabilization is influenced by electoral cycle, where the important factor is especially fear of losing voters. In his model, two fighting parties with very different platforms independently decide whether to raise or not to raise the issue. If one party raises the issue, the other must do it as well. After both issues are presented, voters choose Winner. As the proposals and also policies of two candidates are very different, each candidate fears to raise the issue, because he may end up living under the policy of the other party which is unsustainable for him. This fear induces political inaction and impedes stabilization. According to Howitt and Wintrobe (1995), this particular problem appears mainly in democracies, where the competing parties are dissimilar but have almost equal amount of forces.

5.6 Ideological orientation of parties

There exist also concerns that ideological orientation of the parties may be important for the time of stabilization. Veiga (2008) found out that left orientation of the government increases the probability of the stabilization's failure. Right wing governments are believed to be more concerned about the inflation and thus want to perform the stabilization as soon as possible. This result is compatible with the War of Attrition model, where higher inflation costs of one party induce earlier stabilization. It is therefore possible, that right wing parties will be more sensitive to higher inflation costs and will be prepared to concede earlier.

Veiga (2008) empirically proved that right wing parties realize more successful stabilization than left wing parties. In addition, right wing parties often present themselves as reformists, who do not fear to reduce inflation and implement severe measures. This image helps them to increase their popularity among the voters. However we should point out, that the perception of competence of right wing parties to realize stabilization might be higher than their final ability to do so.

5.7 Cohesion and organization within group

Another factor possibly influencing the stabilization time is cohesion within groups. If the cohesion is strong, e.g. the members of a group share similar ideas and aims, the collective action is easy. But in the group separated into small ensembles with diverging goals and where more people have veto power, whole group is unable to act quickly, because each issue has to be discussed and agreed upon. This has naturally impact on stabilization delay.

5.7.1 One versus more leaders

Group often chooses a representative on whom it delegates its authority and who makes decision instead of the group. This representative is either one single individual or group of several members. The amount of people representing a group may be used as a proxy of cohesion within the groups. If there is one decisive leader, the cohesion is perfect, when there are at least two individuals with decision power, the cohesion is already imperfect. This issue is well analyzed by Spolaore (2004) in paper: "Adjustment in Different Governmental systems".

Even though Spolaore is concerned by characteristics of governmental systems and their impact on stabilization, which cannot be integrated into War of Attrition model, we may use his results in determining the influence of one/more leaders on the time of stabilization. Spolaore suggests that under different governmental settings stabilization proceeds either slower or faster. He uses three governmental systems for his analysis. The cabinet system in which the decision power is held by one single leader, consensus system, where control is shared by many political agents with diverging interests and the combination of both: check-and-balance system, where the power is given to one leader who is limited by n agents able to veto his decision.

The general difference between the two extreme cases is that cabinet system adjust too often, e.g. policy reacts to every small disturbance, and consensus system fail to adjust quickly, because the adjustment succeed only after long discussion about distribution of adjustment costs. This characteristic is related to the number of agents having veto power. With the number of veto agents increasing, the delay increases as well (Spolaore, 2004).

Continental parliamentary systems with proportional representation and where individual groups have extensive veto power over the other's decision is close to consensus system. On the other side, cabinet system may be well represented by the example of Great Britain and check-and-balance by United States (Spolaore, 2004).

The idea that adjustment depends on the type of the government is supported also by Alesina et al. (2006) who found out that stabilization occurs more often in presidential system, which is compatible with our conclusions.

5.7.2 Weaknesses

Although a division between cabinet, check-and-balances and consensus systems is illustrative, it has some weaknesses (Spolaore, 2004). In reality, it is often the case that

decision power is held by one single agent in some areas and divided between several agents in other areas. Therefore, even though each group elects one leader, his authority might be in reality limited.

Furthermore, in comparing delays of stabilization in these systems, we should also pay attention to the process of leader selection, which may be time consuming as well. United States, where this process takes about two years, is a good example to illustrate that leader selection is a relevant factor influencing speed and delay of stabilization. By incorporating this additional variable, the time lag between stabilization's delays of different systems is narrowing, and cabinet system may end up behaving similarly to consensus system. Therefore, it is less obvious which system stabilizes quicker, which slower and which one is thus best in some particular situation.

Finally, according to Spolaore, we should remember that the ability to stabilize sooner is not the only important attribute determining the quality of the government. There are also factors as fairness, responsiveness to changes in society's preferences, etc., which perhaps do not influence the effectiveness in stabilization process, but do influence country's welfare (Alesina et al., 2006).

We can derive some conclusion for War of Attrition model. It is probable, that with one leader, party will probably stabilize sooner than with numerous leaders sharing decisive power. We can also agree, that during the crisis, the group that chooses one leader will be probably more effective than the other one. However, the final impact on its welfare is ambiguous.

Chapter 6

Conclusion

Nowadays, as many developed countries keep running high positive deficits without ability to terminate them, the problem of delayed stabilization modeled in this thesis becomes quite relevant. Those deficits grow even at increasing pace which is mainly due to current world crisis resulting in huge governmental spending into affected industrial areas. In name of fight against crisis countries boost their national economies and increase public expenditure. They follow this strategy although it is obvious that the expansion will have to be compensated in future by extensive contraction which will require deep reform of fundamental institutions.

The aim of this thesis was to study delays in stabilizations through the concept of war of attrition. For theoretical basis, we used game theory. We explained the difference between mixed strategy equilibrium and Bayesian equilibrium, we described, how the beliefs are formed in one period game and we derived Bayesian equilibrium. Then, by addition of time dimension, we modified the original idea of Bayesian equilibrium in order to explain updating beliefs. Finally, we derived Perfect Bayesian equilibrium.

We built our survey on two models established by Persson, Tabellini and Martinelli, Escorza respectively, which enabled us to determine factors influencing stabilization delay. Firstly, we analyzed the equilibrium delay in stabilization in 2-period model of Persson and Tabellini. We found out that stabilization delay is increasing in the society's polarization and decreasing in the size of initial fiscal problem and in welfare losses of groups. Secondly, we described model established by Martinelli and Escorza, in which delay may extend over infinite period. In addition to equilibrium with positive delay, there exists also equilibrium without delay, which is not subgame perfect. We described both equilibria and in the final section we analyzed how can change in welfare losses, inflation and polarization of the society influence stabilization delay

We further investigated additional factors, not incorporated in the models, which can nonetheless affect the stabilization time significantly. Firstly, we analyzed the impact of crisis. According to our study, we can say, that inflation crisis has positive effect on the time of stabilization. We studied the effect of inflation crisis under both war of attrition framework and bargaining framework, where we modeled crisis through lowered discount factors in alternating offers. On the other hand, the effect of political crisis on the time of stabilization is

rather negative. As is depicted in numerous studies, political instability is considered to lead to higher delay in stabilization.

Secondly, we studied the impact of foreign aid. As we saw, the final effect of foreign aid on stabilization is ambiguous. There exist cases, as is e.g. Marshall plan, in which foreign aid helped country to stabilize sooner. However, there are also examples of foreign aids, which were used inefficiently and sometimes even delayed stabilizations. As determinants of foreign aid efficiency, we present moral hazard and delivery channels. We also investigate the possibility that there exists a time gap between announcement of the aid and its delivery.

Due to complexity of this topic, we can say that there exist many further factors influencing stabilization delay beside crisis and foreign aid. Therefore, we explore some of them. We studied the effect of external intervention, which is in the case of very low welfare losses crucial determinant of stabilization. We also found out that stabilizations occur mainly after election and we presented three explanation of this phenomenon. Besides, we examined the effect of ideological orientation of parties and according to recent surveys, we can say, that right wing governments stabilize more often than let wing governments. Finally, we analyzed the influence of cohesion and organization within groups and we can say that group stabilizes most quickly under perfect cohesion (single leader), whereas imperfect cohesion (many leaders) delays the stabilization.

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