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MONETARY EXIT STRATEGY AND FISCAL SPILLOVERS

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Abstract

The paper models strategic monetary-fiscal interactions in the aftermath of the global financial crisis - in a single country as well as a monetary union. It depicts both the short-term (stabilization) perspective and the long-term (sustainability) perspective, and the link between them. This is done in a game theoretic framework that allows for revisions of actions, deterministic or stochastic. In addition, we consider incomplete information about economic conditions, and different types of government. We find that, under ambitious fiscal policies, a legislated long-term monetary commitment may: (i) reduce the risk of a double-dip recession and deflation in the short-term, and at the same time (ii) facilitate the 'exit strategy' of monetary policy, ie prevent sub-optimally high future inflation caused by fiscal spillovers. Our analysis thus implies that an explicit numerical target for average inflation may play the role of a monetary 'credibility insurance' over all phases of the business cycle, and is beneficial especially in countries facing fiscal stress.

Keywords: monetary-fiscal interactions, Game of Chicken, asynchronous moves, stochastic timing, equilibrium selection. **JEL Classification Numbers:** E52, C70.

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1. Introduction

The aftermath of the global financial crisis has presented policymakers all over the globe with major challenges. The degree of uncertainty about economic conditions, and about the desirable course of policy actions has been uprecedented. Unfortunately, economic theory has not provided clear policy recommendations. In particular, economists have differed in their assessment of the danger that (i) the economy may fall into a deflationary trap in the short-term, and that (ii) past and present fiscal and monetary excesses may lead to pressure on central banks to allow sub-optimally high inflation in the long-term.[3]

This paper offers a way of modelling both the short-run and long-run aspects of a post-crisis situation, and the linkage between them. We present the monetary (M) vs fiscal (F) interaction as a strategic game between the central bank and the government. In order to be able to incorporate the effect of institutional features, our main innovation is altering the rules of the game. In particular, we allow the players to revise actions with some positive probability - but not necessarily certainty. This is in contrast to the standard repeated game, in which moves are made simultaneously every period, or alternating move games of Masking and Tirole (1988) in which players alternate every other period. Neither of these timing setups seem realistic in the M and F policy context.

The framework is general in being able to capture an arbitrary timing of the revision opportunity, both deterministic and stochastic (for a detailed exposition see Basov, Libich, and Stehlík (2010)). Incorporating revisions leads to an asynchronous timing of moves, and allows us to postulate the concepts of *long-term M commitment* and *F rigidity*. Both concepts relate to the policy's inability to alter its long-run stance. Their difference comes from our focus on the case of a 'responsible' M policymaker facing an 'ambitious' F policy.[4] Our aim is to examine the effect of M commitment, F rigidity, policy preferences, as well as economic uncertainty on the outcomes of the policy interaction.

Note that unlike the standard (Stackelberg leadership) concept of commitment which is static, our commitment concept is dynamic. In particular, in the standard framework the follower can revise his action immediately, ie there is no cost to the leader from miscoordination or conflict. In contrast, our framework allows for such costs as the revision may arrive later in the game and payoffs accrue over time.

We assume that the timing of the revision opportunity is exogenous and common knowledge. Incomplete information is incorporated into the game by assuming that the policymakers are unsure about (current and near future) economic conditions, and

[3]This pressure is, to a smaller extent, due to the recently undertaken quantitative easing and fiscal stimuli, and to a larger extent due to the unsustainable long-term stance of fiscal policies. To demonstrate, IMF (2009) estimates that in G20 countries the average contribution of the global financial crisis to the long-term fiscal imbalance is only 10.8% of the contribution of age-related fiscal factors. Similarly Gokhale and Smetters (2003) in a study for the U.S. Treasury estimated the long-term U.S. budgetary shortfall to be $65.9 trillion.

[4]Such focus is in line with most of the recent literature (for the terminology see eg Faust and Svensson (2001)). Government's ambition may be due to re-election attempts in the presence of naïve voters, lobby groups, unions etc; or due to inherited F settings such as unaffordable welfare/health/pension schemes, high debt, or liabilities implied by public guarantees for financial institutions. Nevertheless, we will also consider the case of a monetary union in which some governments are responsible.

therefore do not know which game (out of two possibilities) they are playing. Specifically, both M and F policymakers believe that with probability p economic conditions are such that a double-dip recession and deflation are imminent, in which case extra stimulus is required. This is the 'Downturn' scenario represented by an anti-coordination game such as the Game of Chicken. In contrast, with probability $(1-p)$ the policymakers think economic conditions will keep improving and the economy recovers at a good pace without any additional stimulatory measures. This is the 'Normal times' scenario represented by a coordination game such as the Battle of the Sexes.

We show that whether deflation occurs in the short-term, and whether F excesses spill over to M policy in the long-term (thwarting the success of the central bank's exit strategy) depends on the degree of F rigidity *relative* to the strength of long-term M commitment. We identify three main cases: (i) *F-dominance* - the $\frac{F \text{ rigidity}}{M \text{ commitment}}$ ratio is above a certain threshold T_M, (ii) *M-dominance* - this ratio is below a certain threshold T_F, and (iii) *non-dominance* - the ratio is in the intermediate interval.

In the F-dominance case, spillovers will surely occur because F rigidity gives the government an upper hand in the policy tug-of-war. The M exit strategy will be unsuccessful. In contrast, in the M-dominance case F spillovers will surely be avoided as a strong commitment gives the central bank ammunition to counter-act excessive F stance. These results are in the spirit of the unpleasant monetarist arithmetic of Sargent and Wallace (1981).[5] Importantly, in both cases deflation is prevented in the short-term equilibrium. This is because the dominant policy can force the dominated policy to respond to the adverse shock (or, alternatively, force it not to respond if the dominant policymaker prefers to address the economic weakness himself).

The intermediate non-dominance case is of particular interest as it does not exist under static commitment, and therefore has not been discussed in the existing literature. In this case one policy is still more committed/rigid than the other, but insufficiently so to fully dominate the game. We show that in this case F spillovers may occur, but their probability is reduced compared to the F-dominance case because there exist multiple subgame perfect Nash equilibria including the socially optimal ones. Therefore, the chances of a successful M exit are increased relative to the F-dominance case.

Nevertheless, and perhaps surprisingly, the fact that neither policy has sufficient leverage over the other in the non-dominance case may be a possible disadvantage in the short-term. Policies are more likely to engage in a tug-of-war that is costly for both policymakers and society. This conflict can take two forms depending on the underlying policy preferences in the downturn scenario. One possibility is a 'waiting game', in which both policies delay required stimulatory measures hoping to induce the other policy to carry them out. This increases the likelihood of a double-dip recession accompanied by deflation. The opposite tug-of-war case is one in which both policies tend to respond to the shock more aggressively than required to discourage the other's response. This may lead to an excessive combined response, possibly causing macroeconomic and financial imbalances in the future.

[5] Alternative terminology has been used in the literature to describe these two polar cases. F-dominance is analogous to Leeper's (1991) active F and passive M policy; or Woodford's (1994) non-Ricardian regime. On the other hand, M-dominance has been labelled active M and passive F policy; or the Ricardian regime.

We derive the T_M and T_F thresholds that separate the F-dominance, M-dominance, and non-dominance regions of equilibria. They are, in addition to the timing of the policy revisions (ie the degrees of F rigidity and M commitment), shown to be a function of the probability of adverse conditions p, and the policy payoffs. In particular, they depend on the cost of a potential policy conflict relative to coordinated actions. This 'conditionality' refines the intuition of Sargent and Wallace's (1981) findings where the Stackelberg leader (dominant policy) ensures his preferred outcomes under all circumstances - there are no strings attached. It can thus be argued that the results derived under static commitment may not be robust, and the picture they paint for M policy is overly optimistic.

The policy implication is as follows. In order to minimize the probability of *both* deflation in the short-term, and of subsequent F-M spillovers (ie maximize the credibility of a M exit), the central bank should be as strongly committed as possible in the long-term. As the cost of policy conflict varies with economic conditions, a certain degree of commitment that is sufficient for M credibility in normal times is shown to possibly be insufficient in a downturn such as the global financial crisis. It can therefore be argued that strong long-term M commitment acts as a 'credibility insurance' over the business cycle.[6]

In practice, long-term M commitment has commonly been implemented as a legislated numerical target for average inflation: for a treatment see Svensson (1999). A recommendation to adopt such commitment has been recently made by a number of economists, both for short-run and long-run reasons, eg Bernanke (2003), Goodfriend (2005), Hamilton (2008), Walsh (2009), or Mishkin (2010). The following quote by the latter author summarizes these views - stressing effects over both horizons:

> *'Providing a firm anchor for long-run inflation expectations would make the threat of deflation less likely. But a firm anchor would also give the Fed flexibility to respond to the weakness of the economy – because it would help ensure that any new moves to quantitative easing would not be misinterpreted as signalling a shift in the central bank's long-run inflation goal, making an upward surge in inflation expectations less likely too.'*

In summary, our contribution lies in offering a way of modelling the short-run and long-run aspects of macroeconomic stabilization jointly, and highlighting the importance of incorporating strategic interactions of M and F policy on the outcomes of both policies over both horizons. This seems desirable as the horizons are intertwined: current actions affect not only current and future policy outcomes, but also the choice set and payoffs of the policies in the future.

Interestingly, the analysis implies that an explicit M commitment may improve not only short and long-term M outcomes, but also long-term F outcomes. By reducing the structural incentives of the government to spend excessively through a credible threat of a policy conflict, a more explicit long-term commitment can under some (but not all) circumstances discipline F policy and help gain political support for necessary F

[6]While the M-dominance scenario is socially optimal under all circumstances in our benchmark case of a responsible M and ambitious F, the other two scenarios cannot be ranked unambiguously. As discussed above the non-dominance scenario is socially superior to the F-dominance scenario in terms of long-run outcomes, but may be inferior in terms of short-run outcomes.

reforms.[7] These are, as argued convincingly by Leeper (2010) and many others, among the top policy priorities in most countries.

2. The Game Theoretic Setup

2.1. **Actions and Payoffs.** The considered two types of situations potentially facing the policymakers are summarized as 2×2 games

(1)

		F	
		l'	h'
M	L'	a', w'	b', x'
	H'	c', y'	d', z'

Downturn

		F	
		l	h
M	L	a, w	b, x
	H	c, y	d, z

Normal Times

Each policy chooses between two levels: *low*, $\mathcal{L} \in \{L', L, l', l\}$ and *high*, $\mathcal{H} \in \{H', H, h', h\}$. Their interpretation differs across the two scenarios; the 'Normal Times' scenario is of a long-run nature (average stance over the business cycle), whereas the 'Downturn' scenario is about the optimal short-run stabilization actions (how to deal with an adverse shock). Therefore, L can be interpreted as achieving optimally low inflation on average, H as over-shooting that level on average, L' expresses no additional M stimulus, and H' expresses more M stimulus. Similarly, l can be interpreted as a cyclically balanced budget, h as running a structural deficit, l' as no further F stimulus, and h' as more F stimulus.

2.2. **Timing of Moves.** Macroeconomic setups have been commonly studied using a one-shot game, or its repeated analog. In both of these settings players' moves are always simultaneous. In order to relax such synchronicity assumption - arguably unrealistic in the macroeconomic policy context - we will consider the following timing:

(1) Nature makes a move about (current and near future) economic conditions given probability p.
(2) Observing the draw, the players move simultaneously at time $t = 0$.
(3) One of the players, called *reviser*, can move again in time $t \geq 0$ with some (ex-ante known) positive probability, observing the initial play of the opponent. In contrast, the opponent, called the *committed (or rigid) player*, has to stick to his initial choice to the end of the dynamic stage game (normalized to $t = 1$).
(4) Payoffs accrue continuously over $t \in [0, 1]$.[8]

The probability that the reviser has had a revision opportunity can be summarized by a cumulative distribution function (CDF), which we will call a *revision function*. It will be denoted by $R_i(t)$, where $i \in \{M, F\}$ indicates the reviser. Our framework allows for

[7] We discuss below some empirical evidence for this finding.

[8] In Basov, Libich, and Stehlík (2010) we allow *both* players to revise their initial actions on $t \in [0, 1]$. While the solution of the game is much more complex, the intuition is similar which will be discussed below. Let us also note that while the dynamic stage game can be repeated, we do not do so since our focus is on deriving circumstances under which the stage game itself has a unique and efficient subgame perfect equilibrium. In such case allowing for reputation building through repetition would not alter the outcomes.

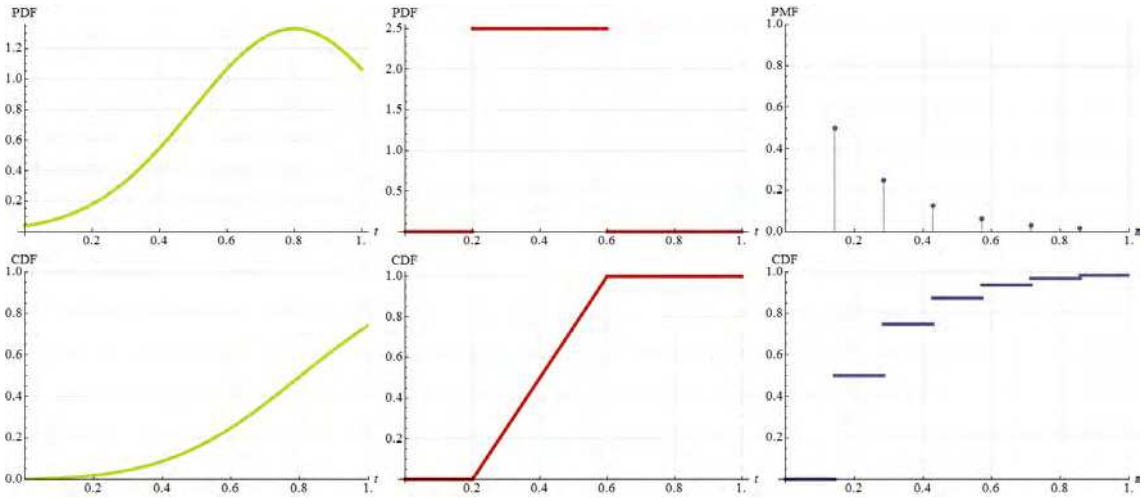

FIGURE 1. Three examples of timing: (truncated) normal, uniform, and binomial distributions, and the corresponding CDFs.

an arbitrary timing, for example normal, uniform, or binomial distributions, the latter in line with the popular Calvo (1983) scheme. Figure 1 offers some examples.

The reaction speed of reviser i can be summarized by $\int_0^1 R_i(t)\mathrm{d}t$. We will allow for $\int_0^1 R_i(1)\mathrm{d}t \leq 1$, ie the revision opportunity may not arrive at all. The complementary CDF, $\int_0^1 (1 - R_i(t))\,\mathrm{d}t$, denotes the reviser's degree of commitment or rigidity.[9] For the committed/rigid player who cannot revise his initial action, the ratio

$$\frac{1}{\int_0^1 (1 - R_i(t))\,\mathrm{d}t} \in [1, \infty]$$

expresses his commitment or rigidity *relative* to that of reviser i.[10]

3. Scenarios Under An Ambitious Government

The general payoffs in (1) are obviously functions of the deep parameters of the underlying macroeconomic model. As such, they depend on the structure of the economy, the expectations and actions of private agents, and importantly policy preferences.[11] Therefore, a number of scenarios - classes of games - can arguably arise. In our benchmark case of a responsible M and ambitious F, we will limit our attention to two classes

[9]Naturally, we have $\int_0^1 (1 - R_i(t))\,\mathrm{d}t = 1 - \int_0^1 R_i(t)\mathrm{d}t$. It is also apparent that as two limiting cases our framework nests the standard one-shot game, $\int_0^1 R_i(t)\mathrm{d}t = 0$, and the static Stackelberg leadership, $\int_0^1 R_i(t)\mathrm{d}t = 1$.

[10]As the dimension of the normal form of the game is now 4×16 we will not present it here. To give an example of the players' action sets S_i, consider the case of M being the committed player, whereby the action sets can be written as: $S_M = \{L'L, H'L, L'H, H'H\}$ and $S_F = \{l'l'll, l'h'll, h'l'll, h'h'll, l'l'lh, l'h'lh, h'l'lh, h'h'lh, l'l'hl, l'h'hl, h'l'hl, h'h'hl, l'l'hh, l'h'hh, h'l'hh, h'h'hh\}$, where the second and fourth action of each strategy of player F denote the revisions.

[11]Libich and Stehlík (2010) offer an example of how macroeconomic models can be truncated into a game theoretic representation such as (1) using the approach of Cho and Matsui (2005).

of games that have been used in the literature to describe the policy interactions most frequently: the Game of Chicken and the Battle of the Sexes. The Chicken scenario will describe the policy interactions in a downturn, whereas the Battle scenario will represent them in normal times. Formally, the payoffs satisfy the following constraints (the payoff matrices below offer examples and indicate the pure strategy Nash equilibria in bold)[12]

$$b' > c' > d' > a' \quad \text{and} \quad y' > x' > z' > w', \tag{2}$$

$$a > d > b \geq c \quad \text{and} \quad z > w > x \geq y, \tag{3}$$

(4)

		F	
		l'	h'
M	L'	deflation $0,0$	recovery $\mathbf{3},\mathbf{2}$
	H'	recovery $\mathbf{2},\mathbf{3}$	over-stimulating $1,1$

Game of Chicken (Downturn)

		F	
		l	h
M	L	Ramsey $\mathbf{3},\mathbf{2}$	tug-of-war $1,1$
	H	tug-of-war $0,0$	spillovers $\mathbf{2},\mathbf{3}$

The Battle of the Sexes (Normal Times)

The normal times scenario follows the coordination game of Sargent and Wallace (1981). The central bank wants to deliver low-inflation, and a cyclically balanced budget allows the bank do do so. Therefore, the bank prefers (L, l), which we assume to be the socially optimal 'Ramsey' outcome in the long-run. In contrast, the ambitious government prefers to spend excessively or avoid necessary F reforms for political economy reasons, and would like the central bank to partly inflate the resulting debt away. Therefore, the government's preferred outcome is (H, h). If the policymakers do not coordinate their actions there will be a tug-of-war between them, leading to inferior off-diagonal outcomes.

The policy preferences and hence payoffs are different in the downturn scenario. This is because the economy requires an expansionary response to the underlying adverse shock in order to fully recover. If neither policy responds, (L', l'), the economy experiences a prolonged recession and possibly a deflationary spiral. Our benchmark specification in (2) and (4) assumes that only one of the policies should respond, but not both. This is to highlight the possibility that a joint response, (H', h'), may be excessive and over-heat the economy, potentially planting seeds for imbalances and bubbles in the future.[13] The specification further assumes that both policymakers prefer the other policy to stabilize the shock: the central bank prefers (L', h'), whereas the government prefers (H', l'). This can be the case for two main reasons: (i) the policymakers do not want to be blamed should their actions fail, and more importantly, (ii) they understand that their additional stimulatory measures jeopardize the pursuit of their preferred long-run actions once the downturn threat is over.[14]

[12] By convention, the first payoff is received by the row player and the second by the column player.

[13] There are views justifying this assumptions, eg Taylor and Ryan (2010) argue in regards to the Fed's response to the dot.com bust: '*The Fed's decision to hold interest rates too low for too long from 2002 to 2004 exacerbated the formation of the housing bubble.*'

[14] For example central banks may resist further quantitative easing (QE) on the grounds that it will make the subsequent exit strategy harder and less credible. Similarly, additional fiscal stimulus deteriorates the long-run fiscal position, and makes it difficult for the government to engange in politically popular spending programs in the future. Our assumptions are in line with Barro (2010) who points out both the substitutability of the two policies in their short-term response, and the potential adverse effect

These assumptions provide a link between the short-term and long-term horizons by postulating that current actions affect the outcomes of the policies, which in turn affect future options and choices. It should however be emphasized that our main findings are independent of these assumptions. We discuss below the fact that they remain valid even if we assume that the policymakers prefer to stabilize the shock themselves, for example because they want to be seen as 'doing something', or simply believe that their policy is more effective in addressing the economic weakness. In such case we would have $c' > b'$ and $x' > y'$ in (2) and (4), but the Game of Chicken would still apply.

While the Battle of the Sexes is a coordination game and the Game of Chicken an anti-coordination game, they are similar: both have two Pareto-efficient pure strategy Nash equilibria, each preferred by a different player, and one mixed strategy Nash that is Pareto-inferior to both pure Nash. This implies that the two scenarios feature both a coordination problem (how to escape the mixed Nash), and a policy conflict (whose preferred pure Nash will be selected). A large body of literature following Sargent and Wallace (1981) has these two features, and hence points to such type of policy interaction.[15]

We can therefore interpret the payoffs as follows. From the central bank's point of view, $(b' - a')$ and $(a - b)$ denote the policy *conflict (or mis-coordination) cost* in downturn and normal times respectively. Analogously, $(y' - w')$ and $(z - x)$ are such costs from the government's point of view. In contrast, the policymakers' *victory gain* (relative to 'surrendering' and complying with the opponent's preferred pure Nash) is expressed by $(b' - c')$ and $(a - d)$ for the central bank, and $(y' - x')$ and $(z - w)$ for the government.

4. Results Under An Ambitious Government

We are interested in deriving the circumstances under which one policy '*surely-wins*' the game. We define this as a situation in which the dynamic stage game has a *unique* subgame perfect Nash equilibrium with the committed/rigid policymaker's preferred outcomes throughout the equilibrium path. As implied by (2)-(3) these outcomes are $(H'H'hh, l'h)$ for an ambitious F, and $(L'L, h'h'll)$ for a responsible M.

Proposition 1. *(i)* ***(F-dominance)*** *F spillovers onto M policy surely* ***occur*** *if and only if F rigidity is* ***sufficiently high*** *relative to long-term M commitment,*

$$\frac{1}{\int_0^1 (1 - R_M(t))\,\mathrm{d}t} > T_M = \frac{p\,(y' - w') + (1-p)\,(z - x)}{p\,(y' - x') + (1-p)\,(z - w)} \in (1, \infty)\,. \tag{5}$$

(ii) ***(M-dominance)*** *F spillovers onto M policy surely* ***do not occur*** *if and only if F*

on future policy options: *'My conclusion is that QE2 may be a short-term expansionary force, thereby lessening concerns about deflation. However, the Treasury can produce identical effects by changing the maturity structure of its outstanding debts. The downside of QE2 is that it intensifies the problems of an exit strategy aimed at avoiding the inflationary consequences of the Fed's vast monetary expansion.'*

[15]For example Adam and Billi (2008), Branch, et al. (2008), Benhabib and Eusepi (2005), Dixit and Lambertini (2003), Barnett (2001), Blake and Weale (1998), Nordhaus (1994), Sims (1994), Woodford (1994), Leeper (1991), Petit (1989), or Alesina and Tabellini (1987). While these papers contain a wide range of modelling approaches and macroeconomic environments, our insights relate to their common conflict/coordination features, and are therefore applicable to all these papers.

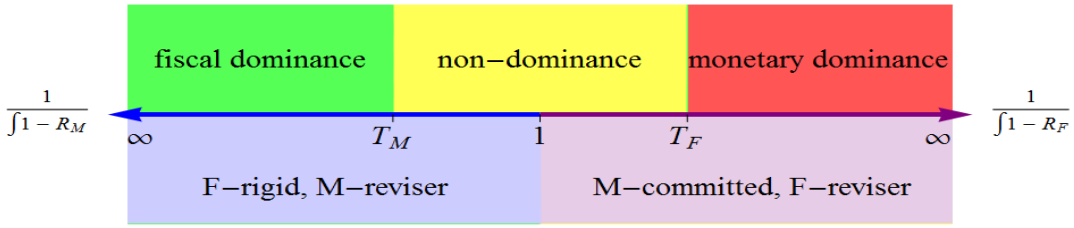

FIGURE 2. The F rigidity vs M commitment space featuring the thresholds and regions of SPNE.

rigidity is ***sufficiently low*** *relative to long-term M commitment,*

$$\frac{1}{\int_0^1 (1 - R_F(t))\,\mathrm{d}t} > T_F = \frac{p\,(b' - a') + (1-p)\,(a-b)}{p\,(b' - c') + (1-p)\,(a-d)} \in (1, \infty)\,. \tag{6}$$

(iii) ***(non-dominance)*** *If neither of the two conditions hold then F spillovers onto M policy* ***may or may not occur*** *in the long-run. Furthermore,* ***deflation may occur*** *in the short-run, unlike in cases (i)-(ii).*

Proof. See Appendix A. □

The results are graphically summarized in Figure 2, showing the two thresholds and the three equilibrium regions. They refine and partly qualify results made under the static commitment concept. First, they show that the committed/rigid policy may not always win the game: its dominance may be insufficiently strong. Second, they identify several variables that determine the required degrees of commitment/rigidity for a policy to fully dominate. Third, they show how uncertainty and business cycle considerations may play a role in the effectiveness of institutional design features such as M commitment. In summary:

Corollary 1. *(i) The thresholds T_F and T_M in (5)-(6) are increasing functions of the committed/rigid player's conflict costs relative to his victory gain - in downturn and normal times weighted by the probability p. (ii) If the cost/gain in downturn exceeds that in normal times then T_F and T_M are increasing in p.*

Let us demonstrate the intuition of the solution focusing on the case $p = 1$, ie the policymakers are certain that economic conditions would not improve in the absence of additional expansionary measures, but prefer the other policy to deal with the problem.[16]

Consider the case of F being the rigid player that is relevant to claim (i). Solving backwards, player F knows that through her own inaction she can force the bank to expand the economy when the bank's revision opportunity arrives. This rewards F for pursuing his preferred outcome $(H'H', l')$. Nevertheless, as the initial waiting game is

[16]This can be loosely interpreted as the 2010 situation in which the Federal Reserve decides whether to pursue another round of quantitative easing, and the U.S. Treasury decides on whether to engange in another fiscal stimulus package. In both cases there may be some short-run benefits, but long-run costs falling primarily onto the institution that carries out the expansion. In addition, the cost of inaction is uncertain but may be high. Finally, the possibility of an inappropriate response creating future imbalances exists.

costly - potentially leading to a deflation - the government's victory reward has to more than compensate the initial cost. Formally, for F to surely-win the game l' must be the unique best response not only to the simultaneously played H', but also to L', ie the following incentive compatibility condition must hold

$$\underbrace{w' \int_0^1 (1 - R_M(t))\,\mathrm{d}t}_{(L',l'):\text{ conflict}} + \underbrace{y' \int_0^1 R_M(t)\mathrm{d}t}_{(H',l'):\text{ victory}} > \underbrace{x'}_{(L'h'):\text{ surrender}}. \tag{7}$$

Rearranging this yields the following condition

$$\frac{1}{\int_0^1 (1 - R_M(t))\,\mathrm{d}t} > T_M = \frac{(y' - w')}{(y' - x')}, \tag{8}$$

which is the special case of (5) under $p = 1$. If satisfied, M will surrender from the start and there is in fact no conflict in equilibrium. The government's threat of inaction becomes credible, and forces the central bank into action. In other words, the area below the CDF, $\int_0^1 R_M(t)\mathrm{d}t$, over which F's victory gain accrues is sufficiently large relative to the conflict cost area above the CDF, $\int_0^1 (1 - R_M(t))\,\mathrm{d}t$.

It should by now be apparent that if M is the committed player, the case of claim (ii), the T_F threshold is just a mirror image of T_M. The intuition is simply reversed: it is now M who is willing to undergo a costly conflict with F, and induce him to expand the economy. Naturally, if the payoffs are symmetric then $T_F = T_M$.[17]

It is also straightforward to see that under the alternative assumption of the dominant policymaker preferring to respond to the underlying adverse shock himself the intuition is unchanged. In such case, if (5)-(6) hold then the dominant policymaker has the power to force the dominated one *not* to respond to the shock, and thus ensure his preferred outcomes. The only difference is the form of the policy conflict. As both policies prefer to respond, the potential tug-of-war would no longer be a waiting game with neither policy responding, but an over-stimulatory outcome with both policies responding.

In which of the three regions of equilibria is the economy most likely to end up? There is little doubt that the degree of F rigidity in most countries including the United States is high, especially taking into account demographic factors. Therefore, unless there exist strong institutional commitment of M policy that anchors the long-run inflation level and prevents the central bank to alter it frequently the F-dominance region seems a real possibility. In fact, the next section will show that under 'ultra-ambitious' governments it may be the case even if such legislated M commitment exists.

5. Extension: Monetary Union with Three Types of Governments

Our benchmark setup focused on the frequently studied case of a responsible central bank facing an ambitious government, F^A. This section introduces two additional types of government: responsible, F^R, and ultra-ambitious, F^U. We do so in the context of a monetary union with a common central bank headed by a responsible governor as in our benchmark specification. To make the analysis illustrative we will focus on the case

[17] Obviously, the reviser cannot surely-win the game: even $\int_0^1 (1 - R_i(t))\,\mathrm{d}t \to 1$ is an insufficient degree of commitment/rigidity for reviser i.

in which the timing of F moves is the same across the three types of governments. This seems natural as the principal opportunity of countries to change their F stance happens in the annual budget.[18]

Denote the proportion of the F^A, F^R and F^U types of government in the union by f^A, f^R and f^U respectively, where $f^A + f^R + f^U = 1$.[19] The overall payoff of the common central bank is a weighted average of the payoffs obtained from interactions with each government type $i \in \{A, R, U\}$, using the weights f^i. The payoff of each government type is directly determined by its own actions and those of the common central bank.[20]

A responsible government will be assumed to prefer the socially optimal outcomes

$$x'_R > z'_R > y'_R > w'_R \quad \text{and} \quad w_R > y_R > x_R > z_R. \tag{9}$$

(10)

		F^R	
		l'	h'
M	L'	deflation $0,0$	recovery $\mathbf{3,3}$
	H'	recovery $2,1$	over-stimulating $1,2$

Downturn (responsible F)

		F^R	
		l	h
M	L	Ramsey $\mathbf{3,3}$	tug-of-war $1,1$
	H	tug-of-war $0,2$	spillovers $2,0$

Normal Times (responsible F)

In (10) we have a 'Symbiosis' scenario (using the terminology of Dixit and Lambertini (2003)) in both the downturn and normal times. This is because both games have a unique Pareto-efficient Nash equilibrium, consisting of the preferred outcome for both players and coinciding with the socially optimal outcome $(L'h')$ and (Ll). This means that if all governments in the union are responsible, this outcome will obtain under all parameter values and any timing. Put differently, deflation, over-stimulating, and F spillovers never occur even if the degree of M commitment is low.

In contrast, ultra-ambitious governments are unwilling to coordinate with the central bank

$$y'_U > w'_U > z'_U > x'_U \quad \text{and} \quad z_U > x_U > w_U > y_U. \tag{11}$$

(12)

		F^U	
		l'	h'
M	L'	deflation $0,2$	recovery $3,0$
	H'	recovery $\mathbf{2,3}$	over-stimulating $1,1$

Downturn (ultra-ambitious F)

		F^U	
		l	h
M	L	Ramsey $3,1$	tug-of-war $1,2$
	H	tug-of-war $0,0$	spillovers $\mathbf{2,3}$

Normal Times (ultra-ambitious F)

Both games in (12) now have a unique Pareto-efficient Nash equilibrium $(H'l')$ and (Hh). Nevertheless, these equilibria do *not* coincide with the central banker's preferred and

[18] It will be apparent below that the timing of responsible and ultra-ambitious governments will not have an effect on the outcomes.

[19] These proportions can express the relative number of such countries, or can be weighted by their economic size - whichever is more relevant in the particular circumstances.

[20] Indirectly, the actions of other governments also have an impact since they determine the action of the central bank, and hence the equilibrium outcomes.

socially optimal outcomes. This means that if all governments in the union are ultra-ambitious, deflation and over-stimulating never occur in the short-term regardless of the degree of M commitment. Nevertheless, F spillovers occur with certainty, and this is true even if the central bank is infinitely strongly committed relative to F rigidity, $\frac{1}{\int_0^1 (1 - R_F(t))\,\mathrm{d}t} \to \infty$.

The above implies that the preferred subgame perfect equilibrium of F^R is the same as M's, whereas F^U shares his preferred equilibrium with F^A. The following proposition is a generalization of Proposition 1.

Proposition 2. *(i)* ***(ambition-dominance)*** *F spillovers onto M policy surely occur iff (5) holds, for which a necessary condition is that the proportion of responsible governments in the union is sufficiently low*

$$f^R < \underline{f^R} = \frac{p(c' - a') + (1-p)(d-b)}{p(b' - d' + c' - a') + (1-p)(a - c + d - b)}. \tag{13}$$

Then deflation is surely avoided under all types of government.
(ii) ***(responsibility-dominance)*** *F spillovers onto M policy surely do not occur iff the proportion of responsible governments in the union is sufficiently high*

$$\frac{1}{\int_0^1 (1 - R_F(t))\,\mathrm{d}t} > T_F = \frac{f^A\,[p(b' - a') + (1-p)(a-b)]}{f^A[p(b' - c') + (1-p)(a-d)] + f^R[p(b' - d') + (1-p)(a-c)] - f^U[p(c' - a') + (1-p)(d-b)]}, \tag{14}$$

for which a necessary condition is

$$f^R \geq \overline{f^R} = \frac{f^U[p(b' - a') + (1-p)(a-b)] - [p(b' - c') + (1-p)(a-d)]}{[p(c' - d') + (1-p)(d-c)]}. \tag{15}$$

While avoided in countries with responsible and ambitious governments, deflation surely occurs in the short-run in countries with ultra-ambitious governments.
(iii) ***(non-dominance)*** *If neither (13) nor (14) hold then F spillovers onto M policy may or may not occur in the long-run. Furthermore, deflation may occur in the short-run under all types of governments.*

Proof. See Appendix B. □

The intuition of our benchmark results carries over. What determines the outcomes of the policy interaction is the degree of M commitment of the common central bank relative to the degrees of F rigidity of ambitious governments, as well as the policymakers' conflict costs and victory gains in both the downturn and normal times.

The additional contribution is showing the mechanism through which responsible governments potentially improve the outcomes, and ultra-ambitious governments make them worse. In particular, if countries with responsible governments make up a large enough part of the M union, then a sufficiently strongly committed central bank is willing to undergo the conflict with the remaining ambitious and ultra-ambitious governments. It knows that ambitious governments will comply in both the short-term and long-term, and hence the exit strategy will be successful. Nevertheless, the ultra-ambitious

governments will not do so, which will in such countries lead to a recession/deflation in the short-term, and continued F excesses in the long-term. Obviously, this may mean a forced departure of such country from the M union the modelling of which is beyond the scope of this paper.

If the M union is composed primarily of the ultra-ambitious governments then even an infinitely strong M commitment may not ensure avoiding F spillovers. Formally, if $f^R < \overline{f^R}\left(f^U\right)$ then the T_F threshold in (14) does not exist, and hence even if all types of government can revise their actions instantly, $\int_0^1 R_F(t)\mathrm{d}t = 1$, the conflict with the F^U types would be too costly for M. This means that in Figure 2 there would only be two rather than three equilibrium regions.

6. Summary and Conclusions

The paper provides a game theoretic framework with revision of actions to examine the strategic aspect of monetary-fiscal policy interactions. By modelling the link between the short-run (stabilization) considerations and long-run (sustainability) considerations the framework can be applied to the aftermath of an economic downturn or crisis - both a single country and a M union setting.

Allowing for asynchronous timing of moves enables us to postulate the concepts of long-term M commitment and F rigidity.[21] We show that the outcomes of the policy interaction, both short-term and long-term, depend on these concepts as well as other variables that affect the magnitude of a potential policy conflict. Importantly, in addition to the standard M-dominance and F-dominance cases of Sargent and Wallace (1981), we identify an intermediate case where the intuition differs from conventional results.

We derive thresholds T_F and T_M that separate these three cases. Given that the magnitudes of the variables affecting these thresholds differ across countries, our analysis offers an explanation for the observed differences in institutional design of both policies. For example, it may explain why some countries have legislated a numerical target for average inflation whereas others have not.

While more research is required to provide definitive answers regarding the desirability of such M commitment for individual countries, the paper offers a general lesson: in uncertain times M policy may need to be committed more strongly/explicitly to cater for a likely increase in the magnitude of the conflict cost. In particular, our analysis implies that without a legislated commitment to an inflation target M policy will be the reviser (follower) in the game. In countries with a high degree of F rigidity this will yield the undesirable F-dominance scenario in which F excesses spill over to M policy. This implies that an explicit commitment serves as a credibility insurance of M policy against F pressure and spillovers over the course of the business cycle.

Interestingly, we show that such commitment may not only improve the outcomes of M policy, but also discipline the government and lead to superior long-term F outcomes too. Franta, Libich, and Stehlík (2010) provide empirical evidence for such disciplining

[21] It is apparent that our long-term M commitment concept is compatible with the timeless perspective pre-commitment of Woodford (1999) or quasi-commitment of Schaumburg and Tambalotti (2007). This is because it does not prescribe (a rule for) how actions need to be changed in response to disturbances, it only restricts the frequency with which the policy stance can be altered.

effect by comparing F outcomes of inflation targeters pre-adoption and post-adoption, and contrasting them with F outcomes of non-targeters.

Nevertheless, it was shown that such disciplining may be ineffective against some (ultra-ambitious) types of governments. Therefore, in such countries (or a M union) governments' incentives need to be altered directly by implementing enforceable F commitments (for convincing arguments see eg Leeper (2010)). The fact that only a handful of countries have implemented some sort of binding Fiscal Responsibility Act with explicit and accountable F targets suggests that the political reality of such an institutional reform may be difficult. The outcomes in Europe teach us that even if legislated, such arrangements may lack traction - especially in a monetary union.

Let us mention two issues regarding the robustness of our findings. First, considering other classes of games would not change our main insights that the strength of M commitment *may* reduce the probability of deflation in the short-term, of F spillovers in the long-term, and that the required strength depends on economic conditions and the type of government. As the extension showed the qualification is that our results obtain weakly (only in some classes of games), but the intuition is never reversed.[22] Second, Basov, Libich, and Stehlík (2010) allow both players to revise their initial actions on $t \in [0, 1]$, and imply that the nature of our results would be unchanged. This is because what matters in coordination and anti-coordination games is the *relative* (rather than absolute) degrees of commitment/rigidity, ie the relative likelihood and speed of the policies changing their stance.

7. References

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[22] For example in the Prisoner's Dilemma game a player's commitment/rigidity does not help escape the inefficient equilibrium, but it does not 'hurt' the respective player either.

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Appendix A. Appendix: Proof of Proposition 1

Proof. Focus on claim (i) whereby F is the rigid player, and recall that her preferred outcome is $(H'H'HH, l'h)$. We need to derive the conditions under which this outcome uniquely obtains on the equilibrium path.

Solving by backwards induction, F knows that when M's revision opportunity comes up, M will play his static best response to F's initial play: both in a downturn and normal times. Therefore, for F to surely-win the game and always play l' and h, it is required that F is willing to undergo a costly conflict with M: both in downturn and normal times. In other words, both l' and h have to be the unique best response not only to H' and H, but also to L' and L. This will be the case if the subsequent (post-revision) victory gain is sufficiently high to compensate F for the initial conflict cost. Formally,

the following incentive compatibility condition needs to hold:

(16)
$$p\left(\overbrace{\underbrace{w'\int_0^1\left(1-R_M(t)\right)\mathrm{d}t}_{(L',l')\text{: conflict}}+\underbrace{y'\int_0^1 R_M(t)\mathrm{d}t}_{(H',l')\text{: victory}}}^{\text{downturn}}\right)+(1-p)\left(\overbrace{\underbrace{x\int_0^1\left(1-R_M(t)\right)\mathrm{d}t}_{(L,h)\text{: conflict}}+\underbrace{z\int_0^1 R_M(t)\mathrm{d}t}_{(H,h)\text{: victory}}}^{\text{normal times}}\right)>$$
$$\underbrace{px'}_{(L'h')\text{: surrender (downturn)}}+\underbrace{(1-p)\,w}_{(L,l)\text{: surrender (normal times)}}.$$

Rearranging yields condition (5) and proves claim (i). The proof of claim (ii), made under M being the committed player, is analogous. The proof also implies that unless both (5) and (6) hold there exist multiple types of subgame perfect equilibria, so neither player surely-wins. This means that deflation and/or F-M spillovers occur in this intermediate region under some circumstances. This completes the proof. □

Appendix B. Appendix: Proof of Proposition 2

Proof. Focus on claim (i) in which M is the reviser, and solve backwards. When M's revision opportunity arrives his best response to the ambitious governments' (l', h) must uniquely be (H', H). Formally, we have the following necessary condition

$$\begin{aligned}(17)\qquad & p\left(f^A c'+f^R d'+f^U c'\right)+(1-p)\left(f^A d+f^R c+f^U d\right)>\\ & p\left(f^A a'+f^R b'+f^U a'\right)+(1-p)\left(f^A b+f^R a+f^U b\right),\end{aligned}$$

which, after rearranging, yields (13). Intuitively, the proportion of the F^A and F^U types, relative to the responsible type, has to be sufficiently high to sway M to comply with them. If satisfied, the central bank would choose to go into conflict with the F^R types rather than the F^A and F^U types to minimize its associated conflict cost.

Moving backwards, both the F^A and F^U types of government have to play uniquely (l', h) in equilibrium, regardless of M's initial play. For F^U this is automatically satisfied (as he has a strictly dominant strategy in the underlying game), and for F^A this is - assuming (17) holds - ensured by (5) derived in the benchmark specification. Then we know that the exit strategy will surely be unsuccessful, as M will play (H', H) from the start.

In terms of claim (ii), M knows that while the actions of F^R and F^U type governments are independent of M's actions, the F^A type's revision will be the static best response to M's initial play. Using this information implies that for M to uniquely play (L', L) the following incentive compatibility has to hold

(18)
$$\begin{aligned}& f^A\left\{p\left[a'\textstyle\int_0^1(1-R_F(t))dt+b'\int_0^1 R_F(t)dt\right]+(1-p)\left[b\int_0^1(1-R_F(t))dt+a\int_0^1 R_F(t)dt\right]\right\}+\\ & f^R[pb'+(1-p)a]+f^U[pa'+(1-p)b]>\\ & f^A[pc'+(1-p)d]+f^R[pd'+(1-p)c]+f^U[pc'+(1-p)d].\end{aligned}$$

This, after rearranging, yields (14), which is just a generalized version of (6) with three types of governments (and nests the benchmark case of $f^R = f^U = 0$). Equation (14)

suggests that if its denominator is non-positive then the T_F threshold does not exist. This implies the necessary condition (15) and completes the proof. □