Central Banks, Trade Unions and Reputation – Is there Room for an Expansionist Manoeuvre in the European Union?

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1 Introduction

In the recent literature on economic policy, an old theme (see Hansen (1967)) has re-appeared[1]: Once the economic policy actor falls apart into different agents – such as the Central Bank and Fiscal Authorities – forming their own and independent preferences and market actors are able to assert impacts on what is commonly taken as endogenous to them (such as Trade Unions on the price level), the simple assignment of single instruments and targets to single actors – the price level (objective) and interest rates (instrument) to Central Banks, the employment level (objective) and real wages (instrument) to Trade Unions and output stability (objective) and fiscal balances (instrument) to the Fiscal Authority – becomes untenable.[2] Since the seminal papers of Barro and Gordon (1983) and Nordhaus (1994), a great number of papers[3] has demonstrated that cooperation among the policy actors gains superior welfare results (a cooperative as compared to a non-cooperative Nash-equilibrium).

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[1]This was only possible, after the policy ineffectiveness hypothesis of New Classical Macroeconomics has lost its dominant grip on the thinking of the economics profession – a development which Akerlof (2007) dubbed the "End of After Keynesian Macroeconomics".

[2]One could think of the assignment of policy instruments to policy actors, involving clear policy rules, as a special case of (*ex ante*) policy coordination. The compliance to the specified policy rules implies the preponderance of a cooperative Nash equilibrium. However, the assumption of compliance would simply rule out strategic behaviour and, thus, assumes away what game theory predicts so relentlessly: rationality with regret.

[3]See e.g. Rankin (1998), Power and Rowe (1998), Dullien (2004), Buti (2003). In other papers – such as Cukierman and Lippi (1999), Guzzo and Velasco (1999) or Jerger (2002) – the interdependence of various policy areas is acknowledged, yet it is seen merely from the perspective of non-cooperative games.

Although this theoretical renaissance is rather new and has certainly not yet gained the support of the entire economics profession[4], it has already left traces in the procedure of policy-making in the European Union: Since 1999, a European Macroeconomic Dialogue (EMD) is established under the provisions of the so called "Cologne Process" in order to do exactly what the policy games literature recommends; i.e. to establish a coordination of the macroeconomic policy areas of monetary, fiscal and wage policy in order to create the macroeconomic environment for sustained growth in Europe (see Heise (2002a)). However, a glance at the figures seems to support those critics[5] which largely deny the efficient working of the EMD:

	Euro-Zone	USA	UK
Inflation rate (consumption deflator)	2.0	2.2	1.8
Real GDP growth rate	2.1	2.9	2.7
Unemployment	8.4	5.0	5.1

Table 1: Selected comparative data on the Euro-Zone, the US and the UK; 1999 – 2006 (annual averages); Source: Commission (2007)

Whatever the reasons may be why the EMD is not efficiently coordinating the macroeconomic policy areas, the question arises as to whether there are other, more viable options for the establishment of cooperation which serves the interests of the actors involved as well as overall welfare? We will argue that the contentious issues could be resolved if European Trade Unions (TU) and the European Central Bank (ECB) took a fresh look at the different options before them. The central question however is, what conditions must be fulfilled in order for the actors not to be entangled in the well-known cooperation traps? The focus of the paper is not on a re-organisation of the European Macroeconomic Dialogue – i.e. no reshaping of institutional

[4]The assignment approach is still preferred by all those who argue on the lines of long-run reasoning (for when even most New Keynesians would recognise the common neutrality postulates) and who fear an obliteration of responsibilities (see e.g. Issing (2001), Issing (2002). For a criticism on this see Jerger and Landmann (2006).

[5]The list of critics is long: see e.g. Allsopp and Artis (2003), Heise (2008b), Collignon (2008), Watt and Hallwirth (2003) and Jerger and Landmann (2006).

incentives[6] – but rather to inquire as to what can be achieved in a context without formal institutions.

The paper is structured as follows: firstly, the theoretical framework underlying our analysis is presented in order to allow the readers to appraise the necessity of policy coordination in general and of an active policy stance in particular. Thereafter, the effects and preconditions for building up reputation are presented. Reputation is discussed as the informal substitute for an institutional setting allowing for cooperative behaviour. Finally, some conclusions are drawn for the possibility of a more growth-enhancing macroeconomic policy mix in the European Union.

2 The underlying Post Keynesian model

The stylised Post Keynesian model presented here is an elaboration of Setterfield (2006) and Heise (2008a):

$$
\begin{aligned}
D_t &= \alpha(w_t, \bar{m}, I_t, \bar{G}, L_t) && (1)\\
Z_t &= \beta(w_t, \bar{T}, L_t) && (2)\\
D_t &\equiv Z_t && (3)\\
p_t &= \gamma(\hat{w}_t, \bar{T}) && (4)\\
\hat{w}_t &= \delta(Y_t^{gap}, \bar{p}_e, \bar{IF}) && (5)\\
Y_t^{gap} &= Y_t - Y_{Trend} && (6)\\
Y_t &= \theta(\bar{K}, L_t, \bar{T}) && (7)\\
I_t &= \lambda(i_t, \bar{E}) && (8)\\
i_t &= \mu(i_t^{CB}, \bar{LP}) && (9)\\
i_t^{CB} &= \phi(p_t^{gap}, Y_t^{gap}) && (10)\\
p_t^{gap} &= p_t - p^* && (11)\\
p_t &\equiv \hat{P}_t && (12)
\end{aligned}
$$

where D is the value of aggregate demand, Z is the value of aggregate supply, w is the nominal wage rate, $\bar{m}$ is the (given) investment multiplier, I

[6] This has been done elsewhere: see e.g. Dullien (2004), Heise (2008a).

is nominal private investment outlays, $\bar{G}$ is (given) governmental spending, $\bar{T}$ is (given) technology, L is the level of employment, p is the inflation rate, $\hat{w}$ is wage inflation, $\bar{IF}$ are institutional factors (collective bargaining system), Y is real income, Y_{Trend} is (given) trend income, $\bar{p}_e$ is the (given) expected inflation rate, K is the (given) stock of real capital, i is the long-term interest rate, $\bar{E}$ is a (given) schedule of expected profit rates, i_t^{CB} is the Central Bank's instrument variable, $\bar{LP}$ is the (given) schedule of liquidity preferences, p^* is the targeted inflation rate.

The model comprises an aggregate demand – aggregate supply section (eq. 1–3) determining the equilibrium employment level, an ordinary production function (eq. 7), a Phillips curve (eq. 5–6), mark-up pricing (eq. 4), a (Taylor-rule) monetary reaction function (eq. 9–12) and a Keynesian investment function (eq. 8). The model is distinctly Post Keynesian in nature, as the employment level depends on the propensity to consume, the incentive to invest, the nature of long-term expectations and liquidity preference considerations (Keynes (1936, p. 250)) and there is neither reason to believe that equilibrium employment (labour demand) just matches labour supply nor any automatic process (e.g. through wage cuts as in Walrasian models) to dynamically adjust supply and demand: as the money supply is endogenously determined, nominal wage reductions will certainly reduce the price level but not necessarily the (real) quantity of money. Hence, the working (and direction) of the real-balance effect and the adjustment path of employment primarily depends crucially on expectation and liquidity preference effects. Although these are not modelled here (as $\bar{E}$ and $\bar{LP}$ in eq. 8 and 9 are taken as given), there is good reason to believe that Keynes was right in pleading for a wage policy (and, hence, a collective bargaining system; i.e. $\bar{IF}$ in eq. 5) which keeps nominal unit labour cost largely constant (Heise (2006a)). Unemployment in such a Post Keynesian framework is not rooted in institutional or market rigidities, yet particular institutional settings of wage and monetary policy[7] can be correlated with distinct employment and inflation performances: the existence of "market constellations" has been the

[7]Of course, fiscal policy should be included. However, for the sake of simplicity, we have not specified any fiscal policy rule. This has been done elsewhere; see Heise (2008a, p. 104 ff.).

object of recent intensive inquiry.[8]

Although the non-accelerating inflation rate of unemployment (NAIRU) concept has been seen very critically by most Post Keynesians (e.g. Galbraith (1997), Davidson (1998), a conflicting claims approach to unemployment and inflation in different institutional settings is fully compatible with the Post Keynesian market constellation concept outlined above. Both, monetary and fiscal policies are able to affect aggregate demand (eq. 1 and 8–10) and, hence, assert measurable impacts on employment and growth. However, the viability and effectiveness of such Keynesian demand management policies rests crucially on the degree of avoidance of social conflict as regulated by the collective bargaining system (see Tsakalotos (2006)) encapsulated in $\bar{IF}$ in eq. 5 and the monetary policy rule as in eq. 10. If a price stability-oriented wage formula were within reach of consciously acting TUs, then the CB could boost the economy without risking soaring inflation.

For Europe such a formula is indeed within reach as recent coordination initiatives of European trade union confederations have shown.[9] As a consequence, the two macroeconomic miseries – inflation and unemployment – could be eased to a certain extent if only the interaction between the ECB and the European TUs would be more coordinated. If cooperation is given a chance, then employment expansion could be reached without formal institutions – which will be shown in the next section by introducing a time horizon and the concept of reputation.

[8]See e.g. Heise (2006b), Heise (2008a), Fritsche, Heine, Herr, Horn and Kaiser (2005), Priewe and Herr (2005).

[9]These were initiated by a resolution of the European Trade Union Confederation (ETUC) in 2000; see ETUC (2000, p. 60). Coordination rounds now exist in many European branches and at ETUC level.

3 Repeated interaction, reputation, and a high employment equilibrium

This section is organised as follows. Firstly, the dilemma of an active central bank (CB)[10] interacting with an uncooperative TU in a single-stage game is considered; then the picture is made somewhat more complex as the possibility of a cooperative TU is added. This reflects the diversity of concepts (and empirical experiences) associated with wage policy (see Hyman (2001)).

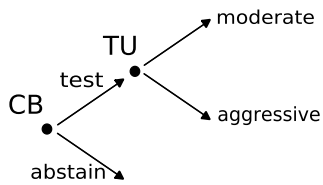

Fig. 1: The single-stage game

The single-stage game is depicted in Figure 1. The most probable outcome is an unemployment rate as high as the initial equilibrium unemployment in a non-cooperative setting (termed here as a "Post Keynesian NAIRU"). But there is also a slight chance that the CB might take the risk associated with employment expansion (if TUs cooperate this risk pays off, otherwise the CB suffers a utility loss). After having analysed this model, another twist will be added with a repetition of the game which allows for reputation effects. It will be shown that this increases the chance for employment expansion.

3.1 *Results in a single-stage game*

The assumption is that the stylised CB's utility function comprises the inflation rate as well as the employment level (eq. 13) while the stylised TU's utility function comprises the growth rate of real wages (i.e. the growth rate

[10] An active (or "bold" as termed by Dullien (2004)) CB can be characterised by a) a high preference for output stabilisation in relation to price stabilisation and b) a symmetric reaction function with respect to deviation of actual inflation from its targeted magnitude.

of nominal wages and the inflation rate) and the employment level (eq. 14):

$$U_{CB} = \psi(p_t, L_t) \tag{13}$$

$$U_{TU} = \phi(p_t, \hat{w}_t, L_t) \tag{14}$$

Moreover, the CB is assumed to move first (see fig. 1). Only this case is considered here because the CB is making decisions more often than the trade unions (i.e. is less prone to large losses because of the immediate possibility to revise action).[11]

The bliss point C of an employment-oriented CB can be seen in Figure 2. It reflects a preference for a target inflation rate p^* and a high employment position or a low unemployment rate u^*, respectively. The "fallback position" F would result from the interaction of an uncooperative TU with a "conservative" CB, which can be seen as the conventional wisdom of the NAIRU model.[12]

This model has an interesting feature: the CB cannot fall below the utility level in F, as will be seen later. The fixed point of this section is an employment-friendly view of the CB. The CB could get to its bliss point C starting from point F by lowering interest rates and stimulating employment expansion (see the economic model sketched above). The CB loss function (from which the utility function derives) is assumed to have standard shape with deviations from target values of unemployment and inflation having quadratic weight:

$$L_{CB} = (p_t - p^*)^2 + b \cdot (u_t - u^*)^2 \tag{15}$$

For the game theoretic considerations undertaken here, which include the analysis of CB behaviour under uncertainty, it is important to note that if the CB puts something at risk by stimulating an employment expansion, it

[11] The frequent decisions of the CB are put forward as an argument for a follower role of the CB in some studies regarding the CB-TU interaction. However, it must be noted here that a concerted first move of European TUs does not resemble the empirical piture so far; see Traxler (2007, p. 111). Another reason to move first may be that the CB wants to signal its "independence" to financial market participants.

[12] It is important to note that the notion of a 'conservative' CB is used here in a slightly different manner than is commonly done. In this article it does not mean a high weight of price stability in relation to output stability but rather an asymmetric reaction function with respect to price stabilisation.

must also consider the possible disinflation costs, which accrue if the TUs choose an aggressive wage policy resulting in an acceleration of inflation. Therefore to cover this case, the CB utility level in point T in Figure 2 also includes the discounted losses incurred by subsequent disinflation process, which is not modelled explictly to simplify matters.

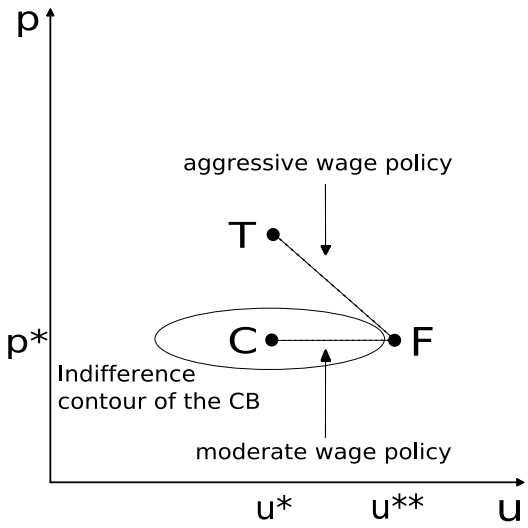

Fig. 2: Different reference points for the CB

The TUs represent the second actor in the game. In the cooperative case it is assumed they will act as a unit. A well functioning wage coordination is a precondition for this.[13] An uncooperative TU will respond to CB-led employment expansion with "aggressive" wage claims. This will subsequently lead to a higher inflation rate. The result is point T on the (short run) Phillips curve in Figure 3, which follows from the special shape of the unions' indifference contours.[14] The indifference contours result from the utility function in eq. (14).[15]

[13]According to Traxler (2003, p. 602) different modes of coordination are possible. It need not be all-encompassing if one takes pattern bargaining into consideration.

[14]The outermost points to the right of each indifference contour constitute the Phillips curve as reaction contour.

[15]See Carlin and Soskice (2006, p. 115) for a graphical exposition and Soskice and Iversen (2001) for an analytical derivation.

If we look at the utility levels of the uncooperative TU depicted in Figure 3, we can see an interesting feature. Payoffs are normalized to values between 0 and 1 for ease of exposition. Least preferred is point F (payoff 0), most preferred is "Temptation" T (payoff 1). The intermediate value d in point C reveals a paradox. Although this value is preferred to the outcome 0 in F, it cannot be attained in an uncooperative 1-stage game. If the CB tests the willingness of the TU to cooperate and chooses unemployment u^*, it is individually rational for the uncooperative TU to press for higher wages. This is also true in a finitely repeated game with perfect information (this follows from subgame perfection).

But what happens if a cooperative TU is introduced? This would result in uncertainty about the TU preferences.[16] Theoretically this scenario could arise based on a different kind of unions' preferences (or utility function). Uncertainty of the CB about the true preferences of the TUs could be the result of a latent principal-agent conflict between union members and their representatives in the TU bureaucracy; see Traxler (2003). Therfore, it does not have to be the case, that the CB is sure of a special utility function of the TUs.

The first preference order is the above-mentioned uncooperative union stance. This could also be regarded as "myopic" because gains in income distribution can only be transitory as follows from mark-up price determination of eq. 4. If the TU does not realize that excessively high wage claims will be passed on to prices and, thus, result in higher inflation, the well-known Phillips curve trade-off between unemployment and rising prices in Fig. 3 arises as a reaction contour of the TU.[17]

The second possible TU preference order is the cooperative policy stance. This could be explained as follows. As mentioned above, the TUs cannot be successful in a distributional conflict. The share of wages in incomes is dictated by the mark-up pricing of businesses. Under these circumstances, it is rational for the unions not to follow the "redistribution reflex" if employment

[16]This point might reflect different experiences with unions' wage policy in the past – see Soskice (1990).

[17]In this case outcome T of Figure 3 results. This can be interpreted as an inflationary Stackelberg equilibrium with monetary leadership.

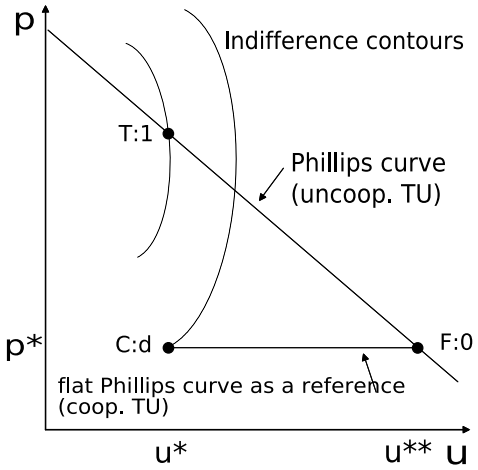

Fig. 3: Preferences of an uncooperative union

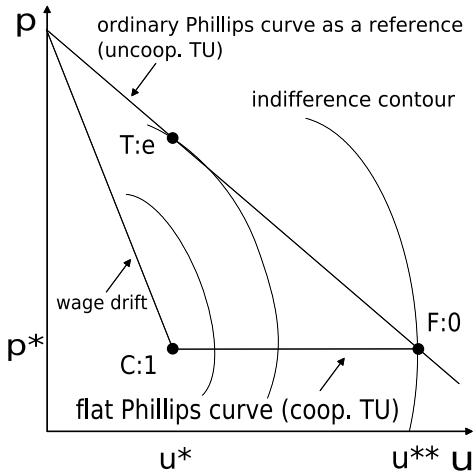

Fig. 4: Preferences of a cooperative union

increases. A rising employment level is in the interest of unions as it improves the power balance in other negotiations such as over working conditions and social security. That is why the cooperative union has a flat reaction contour. In contrast to the steep Phillips curve in Figure 3 it can be argued that the flat Phillips curve is not only short run. If the TU optimizes along the flat Price-setting curve, it will tolerate a high employment levels in the range from u^{**} without triggering a wage-price spiral. Both possible reaction contours of the unions are shown in Figure 4. The flat Phillips curve is in line with the above mentioned argumentation of Soskice and Iversen (2001) and Heise (2002b) that well coordinated TUs can internalize the external effects which can result from too high wage claims.

In Figure 4 the payoffs for the cooperative TU are included. As in Figure 3 they are normalized. The least preferred payoff 0 is attained at high unemployment in point F. An intermediate payoff results from an aggressive wage policy in T. Most preferred is point C with payoff 1. What is interesting here is that the CB can put something at risk if it expands the economy to its own optimum unemployment rate u^*. The acceptance of risk will be rewarded if the TU reacts in a moderate way. Thus, a precondition for the CB considering an employment expansion as rewarding is a certain

probability $\wp$ that the union is cooperative.

In Table (2) we can see three possible outcomes of the game. If the CB takes a risk then two relevant points emerge: T for the reaction of an uncooperative TU and C for the reaction of a cooperative TU. The third point is the fallback position F, where the CB puts nothing at risk.

trade union	central bank	
	test	abstain
cooperative	C	F
uncooperative	T	F

Table 2: Different outcomes in a single-stage game

Note that if the CB doesn't expand the economy only point F can then be reached regardless of which strategy the union chooses. The reason for this is that the two types of union strategies coincide at the unemployment level u^{**} as their reaction contours intersect at this point (see Figure 4). If the CB chooses the unemployment level u^* the TU will react according to its own preference order introduced above. This will prove especially interesting in the repeated game which we shall analyse later on.

If we now introduce normalized payoffs for the CB in the reference points C, T and F, we can integrate all payoffs in payoff matrices. For the CB the highest payoff 1 is assigned to the bliss point C. Payoff 0 can be reached in point T. If we assume a high priority of price stability as a counterweight to the ambitious employment target, point F has the second order with intermediate payoff c – this would entail flat indifference contours of the CB as in Figure 2. A high c means a high relative weight on price stability. In Table (3) and Table (4) the payoffs assigned to the reference points depending on the type of TU are shown.

The strategies "moderate" and "aggressive" refer to the optimum strategies of the cooperative and the uncooperative TU respectively, if the CB chooses the "test" strategy (low unemployment). The payoff pair in the first cell of Table (3) – the pair $(d; 1)$ – stands for a payoff d for the union and 1 for the CB.

trade union	central bank	
	test	abstain
moderate	(d ; 1)	(0 ; c)
aggressive	(1 ; 0)	(0 ; c)

Table 3: Payoff pairs (TU,CB), Case of an uncooperative TU

trade union	central bank	
	test	abstain
moderate	(1 ; 1)	(0 ; c)
aggressive	(e ; 0)	(0 ; c)

Table 4: Payoff pairs (TU,CB), Case of a cooperative TU

Knowing the payoff structure of Table (3) and Table (4) and the probability $\wp_1$ (union is cooperative) the CB can compare the expected utility of expanding the economy or putting nothing at risk. Both strategies are equally rewarding if:

$$\wp_1 \cdot 1 + (1 - \wp_1) \cdot 0 = c \tag{16}$$

The left side stands for the expected payoff of an employment expansion while the right side represents the riskless payoff. The resulting threshold value for $\wp_1$ is the CB's payoff (utility) in point F. Thus, if $\wp_1 > c$ the "test" is more rewarding and the CB will expand the economy in the single-stage game with imperfect information.

The dilemma for the activist CB is that if c increases, an employment expansion becomes very improbable.[18] The result seems paradoxical bearing in mind that (implicit) cooperation would lead to better results for all actors involved (also for the uncooperative TU which is assumed with a certain probability $1 - \wp_1$). This leads to the interesting question of whether the

[18] An example is an employment-friendly CB with a high preference for price stability. The resulting indifference contours are flat ellipses - that is why F represents a relatively high utility level as compared to the value in T.

probability of an employment expansion could be raised if the game were repeated. An answer shall be tried by using the concept of weak sequential equilibrium in the next section.

3.2 *Reputation effects in a repeated game*

In this subsection we will analyse the interaction of the CB and TU in a finitely repeated game that allows for reputation building. As a first step towards a repeated game we will formalise the interaction as a local game, which will be repeated finitely. The whole setting is comprised of n repetitions of the local game from Figure 1. The game resembles the monopoly-entrant game of Kreps and Wilson (1982a), in which a monopoly can attain a reputation for being tough vis à vis potential competitors.[19]

Kreps and Wilson (1982b) have suggested a special equilibrium concept to solve this kind of game: sequential equilibrium. The spirit of that equilibrium can be captured by the strategy "Abstain first or you risk a costly fight." This is not present here, as the payoff structure of the game under consideration suggests another strategy: "Risk something, it could be rewarded." Indeed, an uncooperative union could have an incentive to mirror the behaviour of a cooperative union. This process is called "attaining a reputation". Eventually the probability of employment expansion in the first periods of the game rises.

A weak sequential equilibrium is comprised of a strategy profile and a system of beliefs that satisfy the following two conditions:

1. Sequential rationality: Each player's strategy is optimal in the part of the game that follows each of their information sets, given the strategy profile and their belief of the history in the information set that has occurred.

[19]The original idea stems from Selten (1978). Although the situation seems somewhat similar to our game there are some important modifications. The first affects the payoff structure of Table (3) and Table (4), which is different from Kreps and Wilson (1982a). The second is that the actors don't change from round to round. The CB can put something at risk and choose the strategy "test" or run a more conservative policy, which shall be called the "abstain" strategy. However, the union strategy stays the same.

2. Weak consistency of beliefs with strategies: For every information set reached with positive probability given the strategy profile, the beliefs are updated following Bayes' rule.[20]

The term "belief" is used here to describe the probability distribution that the CB assigns to the TU types.[21] The first condition means that both players play optimally in every point of the game. That means both maximize their expected utility. In particular, an uncooperative TU can behave in such a way that it influences the CB's belief that it is dealing with a cooperative union. The second condition describes the procedure of updating the beliefs by the rule of Bayes, if it can be applied.

Now the equilibrium of the game will be described. Let n denote the number of repetitions in the game, which are counted backwards (period n is actually the starting period). $\wp_i$ stands for the CB's belief in period i that its counterpart is a cooperative union. The first belief must be assumed a priori and it is denoted by $\wp_n = \delta$. As beliefs are central to the reputation argument their updating from period i+1 to period i is described first:

- if CB tests and TU behaves aggressively then $\wp_i = 0$,
- if CB tests and TU behaves moderately then $\wp_i = max\{\wp_{i+1}, c^i\}$,
- if CB abstains then $\wp_i = \wp_{i+1}$.

The first point follows from the fact that only an uncooperative TU is tempted to choose an aggressive strategy if given the chance. The second point reflects the reputation argument with a possible upward development of the belief in the case of cooperative unions. The third point describes what happens if nothing can be learned – the old information prevails.

The strategies of the CB are:

- if $\wp_i > c^i$ then test,
- if $\wp_i = c^i$ then test with probability $1 - d$,

[20] See Osborne (2004, p. 328).

[21] This is adopted from the definitions and preconditions of sequential equilibrium; see Osborne (2004).

- if $\wp_i < c^i$ then abstain.

The CB anticipates that an uncooperative TU will begin engaging to attain a reputation if the initial belief is high enough (or the number of repetitions). That's why it will choose to test if $\wp_i$ passes a certain threshold, which is determined by the relative weight of price stability in the CB's utility – the higher its preference for price stability, the higher the value of c.

The strategy of the cooperative TU can be summed up in one sentence: it will always moderate. For the cooperative TU there is no incentive to play aggressively, either in the short run or in the long run.

The strategies of the uncooperative TU are:

- if $\wp_i > c^{i-1}$ then moderate,
- if $\wp_i \leq c^{i-1}$ then moderate with probability $\frac{\wp_i \cdot (1-c^{i-1})}{(1-\wp_i) \cdot c^{i-1}}$.

Thus, if the initial $\wp_n$ is high enough then the uncooperative TU will choose a moderate strategy for a while to reap the fruits of cooperation.

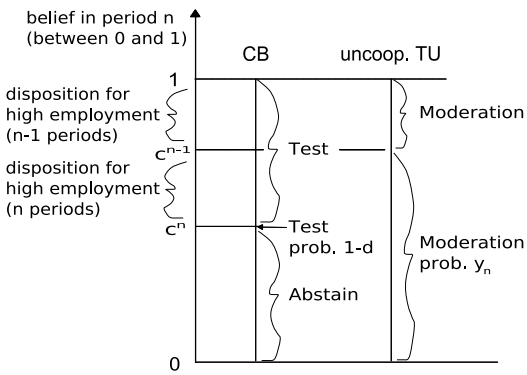

Fig. 5: Optimal strategies in period n

The strategies of CB and uncooperative TU are depicted in Figure 5. One can see on the left scale that by increasing the number of repetitions by one the CB's disposition to employment expansion moves to a higher range. This range is dependent on the payoff c from the CB (see Table (3) and Table (4)), which is determined by the relative weight on price stability in the CB's utility function.

This leads us to the three main results of our analysis:

1. In a repeated game the probability of employment expansion increases with the number of repetitions.

2. For employment expansion to occur, the relative weighting of price stability in the CB's utility function must not be too high, given a certain initial value of the belief $\wp_n$ that the TU is cooperative.

3. For a given value of the CB's relative preference for price stability, the belief in the cooperativeness of the TU must not be too low for an employment expansion to occur.

These results are all derived from the equilibrium strategy of the CB. First, an augmentation of n reduces the initial threshold for the strategy test, as the term $c^n < 1$ diminishes with higher n. Secondly, c^n diminishes slowly if $c \approx 1$. This is the case if there is a high preference for price stabilization (flat indifference contours of the CB resulting in a high c). Thirdly, even with a low threshold for employment expansion, if $\wp_n$ is even lower, then employment expansion is not rewarding for the CB.

The first point is our main result. We have seen above that in a single-stage game the threshold belief in the cooperativeness of the TU is c for an employment expansion to occur. If the game is repeated n-fold, this threshold falls to c^n. We can provide a numerical example of this. If $\wp_1 = 0.9$ in a single-period game the probability of a cooperative TU must exceed 90% for employment expansion to occur. With $n = 5$ repetitions this probability reduces to $0.9^5 = 0.59$. In other words, a 60% probability of a cooperative TU would suffice for the CB to stimulate employment expansion. This may be regarded as the best opportunity for cooperation.

4 Concluding remarks in relation to EMU

In this paper we began with a conventional picture of interaction between CB and TU – the NAIRU model in a Post Keynesian interpretation. This model relies heavily on uncooperative TUs that will trigger a wage-price spiral if given the chance (if unemployment sinks below the NAIRU). The

unconventional results of our above argumentation about effects of reputation can only arise if there is some probability of a cooperative TU.

One could question whether this condition is met in Euroland at the moment. At least in the recent announcements by ECB President Trichet there are appeals to the trade unions to moderate their wage claims in the presence of temporary price shocks.[22] But these appeals might also be seen as part of the ECB's communication strategy. Otherwise one could interpret them as a threat and, though this may augur badly for the future, they may induce the TUs to cooperate. However – as has been shown in the article – if the CB is not sufficiently employment friendly, the TUs cannot archieve a reputation. Thus, mainstream conceptions of monetary neutrality and CB conservatism may actually obstruct the availability of a high employment equilibrium.

If European trade unions are willing and able to use their coordination power at European level to establish a certain stability-oriented wage development[23], this does not mean employment expansion is assured. The ECB mandate gives first priority to price stability. In economic cycles the ECB seems to be quick to brake in an economic upturn but slow to use the accelerator.[24] This causes us to question how employment-friendly the ECB really is. If the ECB does not have a high employment target, potential benefits of wage moderation simply cannot materialize.

To escape the trap of a low employment equilibrium perhaps it would be best for the macroeconomic actors mutually communicate. This is what some Keynesian authors[25] are proposing. That was also the intention of the Cologne Process for macroeconomic dialogue at European level. Such a process could be highly significant, as otherwise it is difficult for the actors involved to identify cooperative contributions in a complicated macroeconomic

[22]See Trichet (2007), Trichet (2008).

[23]On this point see the argument of the Chief Economist of the European Trade Union Institute Watt (2007), who suggests a formula comprised of the CB's inflation target and productivity. The central declaration of the European Trade Union Confederation ETUC (2000) on this matter stresses a different wage formula, which includes actual inflation. So there seems to be some work needed to reach a consensus.

[24]See Bibow (2005, p. 12).

[25]See Dullien (2004, p. 220) and Heise (2001, p. 162 ff.).

environment.

Mathematical Annex

Derivation of equilibrium strategies

First the equilibrium strategies are derived. After that we will show, that they are optimal. We start with an indifference condition for the CB in the last but one period (we have already treated the last period in the 1-period-game):

$$\wp_2 \cdot 1 + (1 - \wp_2) \cdot y_2 = c \tag{17}$$

The left side (LS) are payoffs from an employment expansion, the right side (RS) represents the riskless payoff (no employment expansion). LS payoffs depend on the union type and strategy. A cooperative TU will always moderate (1st summand), while a uncooperative TU will moderate only with probability y_2 (we will derive it below).

From condition 2 of the weak sequential equilibrium we know, that beliefs are updated following Bayes' rule. From that we can establish a connection to the last period:

$$\wp_1^* = \frac{\wp_2}{\wp_2 + (1 - \wp_2) \cdot y_2} = c \tag{18}$$

and this gives us the equilibrium strategy y_2 for the uncooperative TU in Period 2:

$$y_2 = \frac{\wp_2 \cdot (1 - c)}{(1 - \wp_2) \cdot c} \tag{19}$$

Here we can see, how equilibrium strategies are developed in an interplay from the end of game. From backward induction this line of argumentation is well known. Between 0 and c the function y_2 is monotonically increasing with maximum 1 in c. Above c the TU is no more indifferent as she can get a higher payoff by choosing moderation (this will be shown later). Thus, the limiting belief q_2 for the uncooperative TU is c.

If we substitute Eq. (19) in Eq. (17) we get the limiting belief $\wp_1^* = c^2$ for which the CB is indifferent. Strategy test is rewarding if $\wp_2 > c^2$. Below c^2 that point the CB should abstain from an employment expansion. All other equilibrium strategies are derived inductively by similar line of argumentation:

$$\wp_i \cdot 1 + (1 - \wp_i) \cdot y_i = c \tag{20}$$

From our induction hypothesis we get

$$y_i = \frac{\wp_i \cdot (1 - c^{n-1})}{(1 - \wp_i) \cdot c^{n-1}} \tag{21}$$

This is again the equilibrium strategy of the uncooperative TU[26], from which we can get the limiting belief for the uncooperative TU:

$$q_i = c^{n-1} \tag{22}$$

If we substitute Eq. (21) in Eq. (20) we get the limiting belief for the CB in period i:

$$\wp_i^* = c^n. \tag{23}$$

Next the CB behaviour in her points of indifference $\wp_i^* = c^i$ shall be considered. Again the consideration starts at the end of the game. If we formalize an indifference condition for an uncooperative TU in period 2[27] we can derive the CB probability of test in period 1:

$$d + x_1 \cdot 1 = 1 + 0 \tag{24}$$

The LS stands for the sum of payoffs which are possible if the uncooperative TU moderates in period 2 (payoff d) and the CB in turn tests with probability x_1 in the following period 1. The RS includes the payoffs by an aggressive strategy in period 2, after which the CB will choose abstention in period 1. Rearranging Eq. (24) gives us the probability for test of an indifferent CB in period 1:

$$x_1 = 1 - d \tag{25}$$

Derivation of the other x_i is done in the same manner. We just have to bear in mind that the 2nd payoff in Eq. (24) must be replaced by the expected payoff of the remaining i-1 periods (as their are different options for the remaining TU behaviour):

$$d + x_{i-1} \cdot \nu_{i-1}^{TU} = 1 + 0 \tag{26}$$

As the uncooperative TU under consideration was indifferent in period i, she is also indifferent in period i-1. The reason is that the new $\wp_{i-1} = c^{i-1}$ is in

[26]Similar monotonicity considerations as above.

[27]Indifference requires $c > \wp_2$.

the range where the uncooperative TU is indifferent ($\wp_{i-1} \leq c^{i-2}$) – see the construction of TU equilibrium strategies above. That's why $\nu_{i-1}^{TU} = 1$ which is the payoff from aggressive action in period i-1. Knowing this we get:

$$x_{i-1} = 1 - d \tag{27}$$

This gives us all indifference strategies for the CB except for period n. In the starting period the CB is free to choose her x_n as there is no consistency requirement.

Condition 1 of the weak sequential equilibrium: Optimality

The optimal play of a cooperative TU is easiest to verify. If she chooses aggression she can only loose in the short and the long run. One can see this from the payoff matrix (short run) and the fact of foregone payoffs in the future, as the CBs cooperativeness in the future is not enhanced.

The case of an uncooperative TU is more interesting. Before we can show optimality of play we must derive expected payoffs $\nu_n^T U$ from equilibrium strategy. Expected payoffs depend on the initial belief $\wp_n$:

1. $\nu_n^{TU} = 0$ if $\wp_n < c^n$,
2. $\nu_n^{TU} = 1 - d$ if $\wp_n = c^n$,
3. $\nu_n^{TU} = (n - k(\wp_n))d + 1$ if $c^n < \wp_n = c^{k(\wp_n)-1}$,
4. $\nu_n^{TU} = (n - k(\wp_n))d + 1$ if $c^n < \wp_n < c^{k(\wp_n)-1}$,

where $k(\wp_n) = min\,\{i : \wp_n > c^n\}$.

In the first case $\wp_n < c^n$ the CB will never test. Thus the TU gets her minimum payoff 0.

In the second case $\wp_n = c^n$. The expected payoff can be derived indutively. If $n = 1$ we know that the CB is indifferent and tests with probability $1-d$. As it is the last period the TU will choose an aggressive strategy and $\nu_1 = 1 - d$. This is our induction hypothesis. For the induction step we get:

$$\nu_{n+1} = (1 - d) \cdot y_{n+1} \cdot (d + \nu_n(\wp_n^*)) + (1 - d) \cdot (1 - y_{n+1}) \cdot 1 + d \cdot 0 \tag{28}$$

We know from the induction hypothesis that $nu_n(\wp_n^*) = 1 - d$. From this we get:

$$\nu_{n+1} = 1 - d \tag{29}$$

which is what we wanted to show.

For the third case we must assume $\wp_n < 1$ which is trivial. Then we can conclude from our case differentiation that $n \geq 2$. From the definition of $k(\wp_n)$ and the case differentiation we know that in period $t = k(\wp_n) - 1$ we reach the point of indifference which we have treated already in previous case. Thus the expected payoff in the last $k(\wp_n) - 1$ periods equals $1 - d$. In the first $n - (k(\wp_n) - 1)$ periods the TU moderates (see her strategy) and we get the sum of payoffs:

$$\nu_n = (n - k(\wp_n)) \cdot d + 1 \tag{30}$$

The fourth case is very similar to the third case. The switch point is in period $t = k(\wp_n)$. This is the first period where $\wp_t < q_t^*$. Thus the TU plays a mixed strategy in this period, which results in a higher $\wp_{t-1}$ in case of moderation. Thus in case of moderation in period t we switch to a calculation of the remaining expected payoff as in the previous case. The expected payoff then amounts to:

$$\nu_n = (n - k(\wp_n)) \cdot d + y_t(\wp_n)(d + \nu_{t-1}(\wp_{t-1}^*)) + (1 - y_t(\wp_n)) \cdot 1 \tag{31}$$

Knowing $\nu_{t-1}(\wp_{t-1}^*)$ we get:

$$\nu_n = (n - k(\wp_n)) \cdot d + 1 \tag{32}$$

From these 4 cases optimality of play follows straightforwardly:

1. Here it obviously makes no difference how the TU behaves (see payoff matrix).

2. If the TU chooses a different strategy in one of the periods $i \in \{n...2\}$ and $\wp_i > 0$ that doesn't matter for payoffs. The reason is that the CB expects her indifference in these periods and will adapt beliefs accordingly. A higher payoff in period i therefore will result in foregone subsequent payoffs of exactly the same size. Eventually if the TU would switch to moderation in period n she has forgone payoff $1 - d$.

3. Say the TU chooses aggression in period i, which is one of the first $n-k(\wp_n)+1$ periods. This will cause the loss of all subsequent positive payoffs. The payoff sum is reduced to $(n-i)d+1 \leq (n-k(\wp_n))d+1$. If the strategy swith takes place after $k(\wp_n)$, then we can return to the argumentation of the previous case, as the CB expects the TU to be indifferent or there is a real loss in the last period.

4. The argument is similar to the previous case. The only difference is that indifference grips 1 period earlier.

Now let's turn to the CB. Again we start with an induction over her payoffs. Expected payoffs depend on the initial belief $\wp_n$:

1. $\nu_n^{CB} = nc$ if $\wp_n < c^n$,
2. $\nu_n^{CB} = nc$ if $\wp_n = c^n$,
3. $\nu_n^{CB} = n - k(\wp_n) + 1 + (k(\wp_n) - 1) \cdot c$ if $c^n < \wp_n = c^{k(\wp_n)-1}$,
4. $\nu_n^{CB} = n - k(\wp_n) + \frac{\wp_n}{c^{k(\wp_n)-1}} + (k(\wp_n) - 1) \cdot c$ if $c^n < \wp_n < c^{k(\wp_n)-1}$,

where $k(\wp_n) = min\,\{i : \wp_n > c^n\}$ as in the previous case differentiation.

In the first case the strategy test is not taken into consideration. The CB gets her secure payoff all the time.

In the second case the CB is indifferent. We can get her expected payoff inductively. In period 1 the indifference condition

$$\begin{aligned}
\nu_1 &= (1-d) \cdot [\wp_1^* + (1-\wp_1^*) \cdot y_1 + (1-\wp_1^*) \cdot (1-y_1) \cdot 0] + dc \\
&= (1-d)c + dc \\
&= c
\end{aligned}$$

holds. This is our induction hypothesis. We proceed with the induction step $n \to n+1$:

$$\begin{aligned}
\nu_{n+1} &= (1-d) \cdot \left[\left(\wp_{n+1}^* + (1-\wp_{n+1}^*) \cdot y_{n+1}\right) \cdot (1 + \nu_n(\wp_n^*))\right] \\
&\quad +(1-d) \cdot \left[(1-\wp_{n+1}^*) \cdot (1-y_{n+1}) \cdot nc\right] + d(n+1)c \\
&= (1-d) \cdot \left[c^{n+1} + c - c^{n+1} + nc^{n+2} + nc - nc^{n+2}\right] + d(n+1)c \\
&= (1-d) \cdot (n+1)c + d(n+1)c \\
&= (n+1)c
\end{aligned}$$

The third case again rests on the second case. In the first $n - k(\wp_n) + 1$ periods the CB tests and the agressive TU moderates. Payoff $n - k(\wp_n) + 1$ accrues. In period $k(\wp_n) - 1$[28] the CB is indifferent and has an expected payoff $(k(\wp_n) - 1)c$. Together this leads us to the result.

The fourth case rests on the third case. In the first $n - k(\wp_n)$ periods the CB gets payoff $n - k(\wp_n)$. In period $t = k(\wp_n)$ the TU switches to a mixed strategy. Using $y_t = \frac{c(1-c^{t-1})}{1-c^t}$ in the following expected payoff:

$$\begin{aligned}
\nu_t &= (\wp_t + (1 - \wp_t) \cdot y_t) \cdot \left[1 + \nu_{t-1}(\wp^*_{t-1})\right] \\
&\quad +(1 - \wp_t) \cdot (1 - y_t) \cdot (0 + (t - 1)c) \\
&= \wp_t + (n - 1)c\wp_t + \frac{\wp_t}{c^{t-1}} - \wp_t + (1 - \wp_t)(t - 1)c \\
&= \frac{\wp_t}{c^{t-1}} + (t - 1)c
\end{aligned}$$

Together with the payoffs of the periods before $k(\wp_n)$ this gives us the total expected payoff.

Now we are prepared to show that the CB is playing optimally:

1. If the CB plays test in period i her expected payoff in that period is reduced by $c - \frac{\wp_n}{c^{i-1}} > 0$[29]. If there is a future after that period case 2 would apply for the remaining expected payoff, as $\wp_{i-1}$ is updated. Thus the change in expected payoff only affects period i in a downward direction.

2. If the CB behaves different in any period i with $\wp_i > 0$ the uncooperative TU will not recognize it, as she expects a mixed strategy. Therefore nothing changes, especially the expected payoffs stay the same as the CB is acting at her indifference point anyway (the $\wp_i$ are updated to their indifference values in case of previous moderations by TU). If $\wp_i = 0$ because TU has played aggressive once, the CB will loose payoff d if she tests.

[28] As in the above case differentiation $\wp_n \neq 1$ and $n \geq 2$ can be assumed.

[29] To see this one can take the second summand in the expected payoff from case 4 as guideline which derives from the combination of test and moderation with probability y_i. One has also to bear in mind that $\wp_n < c^n$.

3. If the CB chooses abention in one of the first $n - k(\wp_n) + 1$ periods, her expected payoff in that period is reduced to c. Subsequent payoffs don't change as the beliefs stay the same. If the CB changes her strategy after period $k(\wp_n)$ there is no change in expected payoffs (see argumentation in case 2).

4. The argument is similar to the previous case. The only difference is that if the CB abstains in period $k(\wp_n)$ there is foregone payoff $\frac{\wp_n}{c^{k(\wp_n)-1}} - c > 0$. After period $k(\wp_n)$ the CB would abstain further, but that wouldn't affect payoffs from these periods.

Condition 2 of the weak sequential equilibrium: Consistency

According to the second condition of weak sequential equilibrium beliefs shall be updated following Bayes' rule whenever possible. In period i (≥ 2 as $\wp_{i-1}$ shall be updated) this matters if the uncooperative TU is assumed to play a mixed strategy – this is the case if $\wp_i \leq c^{i-1}$. If the TU behaves aggressively the CB takes this as a proof for an uncooperative TU. Otherwise if the TU moderates the CB updates her beliefs.

In period i the uncooperative TU will choose probability $y_i = \frac{\wp_i \cdot (1-c^{i-1})}{(1-\wp_i) \cdot c^{i-1}}$ for moderation. If we choose co./unco. as abbreviations for the incidence that there is a cooperative/uncooperative TU and mod. for moderation we can apply Bayes' rule for the derivation of $\wp_{i-1}$:

$$\begin{aligned}
\wp_{i-1} &= P(\text{co.}|\text{ mod.}) \\
&= P(\text{co. and mod. } | \text{ mod.}) \\
&= \frac{P(\text{mod. } | \text{ co.}) \cdot P(\text{co.})}{P(\text{mod. } | \text{ co.}) \cdot P(\text{co.}) + P(\text{mod. } | \text{ unco.}) \cdot P(\text{unco.})} \\
&= \frac{1 \cdot \wp_i}{1 \cdot \wp_i + y_i \cdot (1 - \wp_i)} \\
&= \frac{\wp_i}{\wp_i + \frac{\wp_i \cdot (1-c^{i-1})}{(1-\wp_i) \cdot c^{i-1}}(1 - \wp_i)} \\
&= \frac{\wp_i}{\wp_i + \frac{\wp_i \cdot (1-c^{i-1})}{c^{i-1}}} \\
&= c^{i-1}
\end{aligned}$$

This is the formula for the updated $\wp_{i-1}$ which was posited in the equilibrium CB strategy as the first part of $\wp_{i-1} = max\{\wp_i, c^{i-1}\}$ was supposed to be smaller then c^{i-1} in the outset.

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