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**Book**

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Juha Kilponen

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Theory and Econometric Evidence

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The views expressed in this study are those of the author and do not necessarily reflect the views of the Bank of Finland.

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# Abstract

In this study, the determination of optimal monetary policy in unionised economies is considered from the new political economy point of view. In the empirical part of the study it is shown that, in addition to the institutional position of the central bank, labour market institutions also matter for successful anti-inflationary policy. As regards the position of the central bank, the results suggest that it is important to distinguish between the political independence of the bank and the independence of its personnel. Whereas the former helps to reduce inflation, the latter seems to produce lower unemployment and wage increases. As regards the effects of labour market institutions, the results indicate that co-ordination in wage bargaining is generally beneficial to inflation and employment, but that large differences between union density and coverage rates lead to higher wage increases and unemployment.

The theoretical part of the study considers interaction between monetary policy and wage determination in unionised economies. It is shown how the benefits of delegating monetary policy to an independent, conservative central bank depend on the degree of centralisation or decentralisation in wage determination. If unions act as leaders in the “inflation game”, which could happen if wage contracts are of very long duration, output in the economy remains inefficiently small. The size of this problem is the greater the more accommodative monetary policy is and the higher is the degree of centralisation in labour markets. It may be beneficial for the unions to give up their leadership position in the determination of inflation.

Key words: monetary policy, credibility, labour markets

# Tiivistelmä

Väitöskirjassa tarkastellaan optimaalista rahapolitiikkaa taloudessa, jossa ammattiliitot vastaavat palkkaneuvotteluista. Lähestymistapa on ns. uuden poliittisen taloustieteen mukainen. Työn empiirisessä osassa osoitetaan, että inflaatiota hillitsevän talouspolitiikan menestys riippuu paitsi keskuspankin asemasta myös työmarkkinainstituutioista. Keskuspankin asemaan liittyvät tulokset viittaavat siihen, että on tärkeää erottaa toisistaan pankin poliittinen riippumattomuus ja sen johdon riippumattomuus. Pankin poliittinen riippumattomuus vähentää inflaatiota, kun taas johdon riippumattomuus pienentää työttömyyttä ja hillitsee palkkojen nousua. Osoittautuu myös, että palkkaneuvottelujen koordinointi on yleensä edullista inflaation ja työllisyyden kannalta, mutta erot järjestäytymisasteen ja sopimusten kattavuuden välillä kasvattavat palkkavaatimuksia ja pahentavat työttömyyttä.

Tutkimuksen teoreettisessa osassa analysoidaan rahapolitiikan ja ammattiliittojen hallitseman palkanmuodostuksen välistä vuorovaikutusta. Työssä osoitetaan, miten edut, joita saadaan delegoimalla rahapolitiikka itsenäiselle, konservatiiviselle keskuspankille, riippuvat palkkaneuvottelujen keskittyneisyydestä tai hajautuneisuudesta. Jos liitot toimivat ns. inflaatiopelin johtajina, kuten voi käydä hyvin pitkien palkkasopimusten tapauksessa, peli johtaa siihen, että tuotanto jää tehottoman pieneksi. Tämä ongelma on sitä suurempi, mitä mukautuvampaa keskuspankin rahapolitiikka on ja mitä keskittyneempiä työmarkkinat ovat. Liittojen edun mukaista saattaa tällöin olla luopua johtajuusasemastaan inflaation määräytymisessä.

Asiasanat: rahapolitiikka, uskottavuus, työmarkkinat

# Foreword

Accomplishment of this thesis would not have been possible without my supervisor, Professor Mark Salmon, and several colleagues, teachers and friends in the European University Institute and Florence. I am indebted to my supervisor Professor Mark Salmon and Professor Mike Artis for their encouragement and guidance. I would like to thank Professor Andrew Hughes-Hallett and Professor Matti Pohjola, who gave me very valuable comments on the final revision of my thesis. I would like to acknowledge a financial support of the Academy of Finland. Without their scholarship I would not have had chance to experience this all. The European University Institute and the Department of Economics provided an inspiring environment and good facilities to work towards a completion of this thesis. I would like to thank also the Bank of Finland for providing me excellent facilities to make a final revision on my thesis in Spring 1999. I have greatly benefited from the comments of David Mayes, Juha Tarkka, Jouko Vilmunen and Matti Virén from the Bank of Finland. Several colleagues and friends made my years in Florence an unforgettable and the most pleasant experience. Special thanks to Steffen and Angela, Paul, Fiorella, Roman, Johanna, Julian, Claudio and Alison, and Benoit, who took me on the Alps and on lengthy biking tours in Toscana countryside. I am indebted also to Salvatore, Isabella and Elena from Studio Goshindo for their grand kindness and hospitality. Finally, I am indebted to my parents, Pasi and Anne-Mari, and Riikka and Jari. Their moral support has been essential. Remaining errors and deficiencies are under my own responsibility.

Helsinki, March 2000  
Juha Kilponen





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# 1 Introduction

## 1.1 Optimal control approach

During the last 25 years economic policy theory and policymaking have undergone drastic changes. Economic policy analysis, until the mid 70s, rested on the so called optimal control approach, originally developed by Tinbergen (1952, 1954) and Hansen (1958). They had demonstrated how policymakers could utilise their policy instruments efficiently to achieve pre-specified policy targets. This optimal control approach consisted of an optimisation problem which represented the preferences of policy-makers under the constraint of a static linear model describing the functioning of the system (economy). The optimal control approach seemed to provide a practical way of designing the optimal policy, control the economy and make a useful contribution to the overall stability of the economy. In this *optimal control approach*, the policy process was perceived in a similar way as in the system models developed by Easton (1965) and Deutch (1963) in political science and in the engineering literature. The setting of economic models involved a rational actor who aimed to maximise utility with the basic principles of formulating policy goals and values, assessing alternatives, attaching probabilities to different strategies in achieving pre-specified goals and finally selecting those which were most likely to achieve the targets.

In this optimal control approach the policymaker was seen as an actor who was an indispensable part of the economic system and it applied strictly to a single decision made at given point of time by a single decision-maker; any strategic interaction between public and policymakers was missing.<sup>1</sup>

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<sup>1</sup>For detailed discussion see e.g. Chow (1981).

## 1.2 Rational expectations –implications to economic policy making

The rational expectations revolution<sup>2</sup> at the beginning of 1970s showed that the early optimal control approach was flawed. The notion of adaptive expectations was employed, but the main problem was that agents were able to make systematic expectational errors. *Adaptive expectations attributed “no-response” to the private sector*, in the case of altered government policy rules (Sargent, 1996). Muth (1961) proposed a radical approach to the problem of modelling individual expectations. Muth’s (1961) hypothesis that the subjective probability distribution of outcomes tend to be distributed about the prediction of the rational theory became to be known as the rational expectations hypothesis. The hypothesis that subjective forecasts are based on an objective distribution represented a radical departure from the all previous approaches in the literature that stressed the importance of uncertainty.<sup>3</sup>

Towards the end of 60’s the expectations of the private sector started to play an important role in the optimal control approach. However, it was still thought that policymaker would be always “more clever” than the private sector. In this way, policymakers could always efficiently *control* the economy. Indeed, even at the end of 60s, mainstream macroeconomics regarded economic policy mostly as a “game against the nature” in which optimal setting of policy instruments were determined by solving the economy’s econometric model for given policy targets. As with fiscal authorities, the monetary authorities’ task was largely considered to be that of balancing inflation and unemployment through demand management policy. Supporters of discretion-based policies and rule-based policies, Friedman (1969), were debating the feasibility

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<sup>2</sup>Until the rational expectation revolution, it was widely thought that expectations behaviour contained psychological and sociological elements and hence could not be modelled with only the tools of individualistic optimisation calculus and statistical decision theory. The attractive power of the rational expectations hypothesis for economic analysis was twofold. First, the hypothesis seemed to offer a formal way of understanding how agents perceive reality and form their beliefs. Secondly, the rational expectations hypothesis seemed to integrate individual expectations formation with the maximisation postulate of the classical theory. The implication was that the economists could use standard choice theoretic tools to treat the acquisition of knowledge and information like any other economic decision (Frydman and Phelps (1983).

<sup>3</sup>Muth (1961, p. 316) argued against the earlier models, because “[...] dynamic economic models do not assume enough rationality”.

of activist (discretionary) policies, while it was generally accepted that “discretionary” policy could in principle be optimal. Discretionary policy was seen to be optimal if the policymakers had sufficient knowledge of a few key parameters of the economic system. Friedman (1969) pointed out that if monetary policy had only short-run and highly unpredictable influence on the economic system, the rule-based policy would be recommended.

Events in the mid-seventies enhanced this debate, since Keynesian economics could not provide a useful explanation for a simultaneous increase in inflation and unemployment. Friedman (1968) and Phelps (1967) had already put forward explanation for this phenomenon. They had demonstrated that there is *no permanent trade-off between inflation and unemployment*. Increased inflation can lower the unemployment rate only as long as people mistake higher absolute prices for higher relative prices for goods or labour. Friedman and Phelps assumed that they would come to anticipate correctly the effect of inflation and hence this reaction had to be taken into account.

At the same time, series of papers by Robert Lucas popularised the rational expectations hypothesis and substantial adjustments in the modelling strategies of macroeconomic policies took place subsequently (Sargent (1996)). Lucas (1972, 1973, 1975) formulated his own version of Phelps’ (1970) island parable. Lucas’ (1972) paper formulated a version of Friedman and Phelps’ natural rate theory that was consistent with the new equilibrium concept of rational expectations and displaced the older distinction between short and long run in favour of one between expected and unexpected outcomes. Subsequently, Sargent and Wallace (1975) used the Lucas (1973) model to derive a striking *policy ineffectiveness proposition*.<sup>4</sup>

Kydland and Prescott (1977) in their influential article criticised the usage of optimal control theory in the practical policymaking and argued that active stabilisation can be hazardous when the private sector has rational expectations. They argued that optimal control theory is an appropriate planning device only when current outcomes and the movement of the system’s state depend upon current and past policy decisions and the current state. This is unlikely to be the

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<sup>4</sup>The policy ineffectiveness paradigm has been closely associated with the rational expectations hypothesis, although it has been demonstrated in the context of dynamic policy models, that the rational expectations per se does not result in policy ineffectiveness. See for instance Petit (1991).



case in dynamic economic systems because the current decisions of economic agents depend upon their expectations of future policy actions. Furthermore, Lucas (1976) in so called *Lucas critique* demonstrated that economic policy affects the estimates of econometric models and makes optimisation techniques based on the econometric model an inappropriate tool for the analysis of economic policy.<sup>5</sup>

Finally, Barro and Gordon (1983a) demonstrated that since rational agents discount the incentive of the policymaker to engineer surprise inflation, they will adjust their behaviour accordingly with the end result that the economy will be subject to *inflationary bias*. Inflationary bias was seen to be due to the government's incentive to "cheat" the private sector in order to keep employment at its desired level. This gave rise to a large literature of credibility and time consistency and resulted in the so called *new political economy approach* to economic policy.

The general approach of this new political economy is to explain deviations in observed economic policy from a hypothetical social optimum by appealing to specific (dynamic) incentive constraints in the decision problem of optimising policymakers. The positive analysis identifies the relevant incentive constraints, while the normative analysis focuses on institutional reforms which may relax them (Persson and Tabellini (1997)). In this vein, this recent theory emphasises non-cooperative hierarchical games between the government and an intelligent forward looking private sector.

The critical aspect of the new political economy approach is that it can generate a link between institutions and macroeconomic policy. The policymaker(s) are no more seen as passive actors, but actors who's objectives and constraints correspond to the real world political institutions in such a way that politics, policy and institutions are deeply interconnected. Political incentives, the structure of the electoral system, the structure of the labour markets, heterogeneous voter etc. can influence the intrinsic objectives of the policymakers, their willingness to deviate from them and the mechanisms through which the politically motivated policymakers could be constrained by objectives that do not conflict with the public or preannounced targets. (Persson and Tabellini (1990)).

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<sup>5</sup>For recent criticism of the Lucas critique see for instance Marcellino and Salmon (1997).

## 1.3 Curbing inflation

### – An overview of the concepts and theory

#### 1.3.1 The new political economy approach and incentive constraints

In this widely celebrated approach, the economic policy process is modelled as a principal-agent problem. An agent is policymaker or collection of agents responding to specific incentives and constraints. The private sector is considered as a principal who has typically forward looking expectations which induces a different kind of (dynamic) incentive constraints for the agent.

One of these constraints is related to a possible conflict of interest between the policymaker and the private agents in their political role. These constraints are called political constraints. A second type of constraint corresponds to a conflict of interest between the policymakers and private agents in their economic role. Persson and Tabellini (1990) name the latter as credibility constraints.

The source of political constraints derive from voters who evaluate differently the effects of particular policies, due to the heterogeneity with respect to their wealth and relative position in the income and wealth distribution. Political institutions, whose essential task is to translate citizens' preferences for the politicians, shape the incentives of the policymakers. In this way institutional structures are linked to economic policy and possibly reflect the dispersion of the macroeconomic performance of different economies. In general, we may think that the capacity of different political institutions to solve appearing problems and conflicts among parties are conditional on the institutional structure of the system itself. It is also likely that these institutional structures are at least partially endogenously determined in the sense of being subject to changes and reforms when the economy faces political and/or economic crises. When political constraints are made explicit in the models- which is not always the case- authors call an equilibrium "a political equilibrium". Such a solution of the model is said to be politically feasible and satisfies rationality and the economic constraints (Persson and Tabellini, 1990, p. 2).

The source of credibility constraints, in turn, derive from the possible difference between private sector's expectations on a certain policy action

and policymakers incentives to pursue that (pre) announced policy. One such credibility constraint may arise from a familiar time inconsistency problem, originally set forth by Kydland and Prescott (1977) in the context of monetary policy. In the context of a monetary policy game, Kydland and Prescott famous inflation-unemployment example rested on the notion that for any well intentioned policymaker, the marginal benefit of lower unemployment arising from a small positive inflation surprise would outweigh the costs of higher inflation. Surprise inflation was thought to be in excess of the realised inflation and which had been anticipated when wages were set. In the rational expectations equilibrium any such “surprise” inflation would be anticipated, and there would be no social benefit from actual inflation deviating from expected inflation. Kydland and Prescott argued that the resulting inflation bias would be eliminated by a simple and transparent monetary rule.<sup>6</sup> Kydland and Prescott hinted also of the need to establish “*institutional arrangements which make it difficult and time-consuming process to change the policy rules*” (Kydland and Prescott, 1977, p.487).

A credibility concept was then introduced by Barro and Gordon (1983b). In principle, they questioned whether following a fixed policy rule, suggested by Kydland and Prescott (1977), would be *credible*.

### 1.3.2 Credibility and time consistency

At the simplest level credibility means that policymakers can convince the public to accept and act upon the (pre) commitment they make, that is, to use some particular policy rule. The public may believe them only when adherence is verifiable or sufficiently a large penalty is attached to renegeing. The incentive to deviate from the (pre) announced policy may arise from several reasons, the bottom line being that there is a conflict between the private sector and policymaker. The credibility problem is therefore additional to time consistency problem. The time inconsistency is a problem of the suboptimality of discretionary policy, when the private sector has forward looking expectations, while the credibility problem arises only when the policymakers would like to follow a particular (pre) announced rule in the face of forward looking agents. Time consistent

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<sup>6</sup>Kydland and Prescott (1977) also showed that discretionary policy could be destabilising.

policy is suboptimal because there is no mechanism to induce future policymakers to take into consideration the effect of their policy via the expectations mechanism, upon the current decisions of agents. Some authors have misunderstood that time inconsistency is due to the short time horizons, myopia, of the policymakers. Kydland's and Prescott's point was, in fact, that any positive discount rate will result to some degree in a time inconsistency problem.

In theoretical models credibility is defined in different ways. For instance, Cukierman and Meltzer (1986) define credibility as "*the absolute value of the difference between the policymaker's plans and the private sector's beliefs about those plans*" (Cukierman and Meltzer (1986), p. 1108). In this view, the public does not know whether policymaker is credible or not. Faust and Svensson (1998) argue that credibility of an announcement is something judged by those to whom the announcement is made. Therefore, they define credibility as a difference between the announcement of the first best policy (a zero-inflation policy) and the expectations that the private sector has about implemented policy. In all events, a lack of credibility is not desirable, because it hinders the policymakers' ability to deviate from suboptimal- and possibly destabilising- discretionary policy.

Insights from the credibility discussion gave rise to a large literature which attempted to solve the time inconsistency problem. These proposals can be broadly divided into two groups. The first approach uses the threat of a loss of reputation to reduce the government's incentive to renege on its original policy. The second approach relies on some external constraints, such that the government finds it optimal to follow some form of time consistent policy.

### 1.3.3 Reputation

The reputational elements were introduced into the models by allowing repeated interactions between the policymaker and the private sector and designing the expectation formation mechanism of the private sector (the so called trigger strategies) so that deviations from the announced policy would be punished by the public.<sup>7</sup> It is typically shown that

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<sup>7</sup>Other contributors of this field include Barro (1986), Blackburn and Christensen (1987), Tabellini (1985, 1987), Vickers (1986).

the precommitment solution can be implemented if the costs of the reputational loss of the policymaker in the case of renegeing are higher than without renegeing. According to Barro and Gordon (1983b), reputational forces can push the economy away from the discretionary (or time consistent) equilibrium. Subsequently, Backus and Driffill (1985) – which was based on Kreps and Wilson (1982) – demonstrated that the sequential equilibrium is the best credible policy and that the sequential equilibrium is dominated only by the fully believed zero inflation commitment. That is, the solution is dynamically consistent. This implies that in the presence of public scepticism about the type of the policymaker, the sequential equilibrium is at least as good as the time inconsistent ex ante optimal policy of setting inflation at zero for all periods.

The Backus and Driffill (1985) analysis treated reputation or credibility as a time dependent (endogenous) state variable, which measures the public's subjective probabilistic beliefs about the policymaker's preferences. The most appealing feature of the model is that the resulting sequential equilibrium allows fluctuations on inflation and output, which depend upon factors such as time horizon, the discount rate, and the stock of reputation. However, the prediction of the model, that it is optimal for the policymaker to choose *a randomising policy* is less appealing and unrealistic.

In common with many trigger strategy equilibrium, there is a multiplicity of equilibrium depending upon the public's prior beliefs about the preferences of the government (Evans (1990)). Moreover, the implementation of the trigger strategies by the private sector needs a substantial degree of co-ordinated action. In decentralised economies it is hard to see how such co-ordinated actions could be implemented, because, these models typically use a representative agent framework.

Moreover, to rely only on an idea that a good reputation can substitute for commitment by some external constraints or by institutions is problematic. Recent theoretical evidence shows that there exist systems of expectations within which a policymaker finds himself trapped into a bad outcome, and which induce her to conform to inflationary reputation. Cho and Sargent (1996) analyse whether a certain theory of learning reputation would narrow the range of outcomes expected from a reputational mechanism. They are able to show that the introduction of learning sharply reduces the range of outcomes to be expected, well below those described by the folk theorem. However, simulation results of the  $(2 \times 2)$  game show that the game still frequently converges to the "bad

outcome” i.e. to the Pareto inferior Nash equilibrium. They conclude that “*reputations alone cannot be relied on to substitute for a commitment mechanism, because there are so many reputations and outcomes*”. Also Chari et. al. (1996) account for the dangers of an “expectation trap” in monetary policy. Chari et. al. (1996) argue that policymakers can be pushed into pursuing inflationary policies, when the private sector expects high inflation. A novelty of their study is that, when there does not exist an external commitment technology expectations of high inflation, which may result from a transitory shock, lead the economy to conform to the high inflation equilibrium for long-time periods. This occurs because the monetary authority finds it optimal to accommodate the private sector’s high inflation expectations if the cost of not doing so is a recession.

Two important consequences arise from these findings. First, the reputational approach shows that the achievement of credibility is costly. In Backuss and Driffill’s analysis, higher unemployment promotes credibility, thereby leading to improved future opportunities. On the one hand, the private sector can be persuaded by actions, not just words. On the other hand, due to the costs of reputation building, it might not be (politically) feasible to establish reputation. Second, some external constraint, that would facilitate commitment seems desirable, even if reputation building was not too costly. This is due to the possibility of expectations traps, as highlighted by Chari et. al. (1996).

#### 1.3.4 External constraints

In the second approach, attention is restricted to equilibrium in which the government always finds it optimal to follow some form of time consistent policy (e.g. Buiter (1983), Miller and Salmon (1985a), Cohen and Michel (1988)). This is achieved by focusing on an equilibrium where the government’s strategic advantage over the public is restricted. This requires the government to eschew its ability to manipulate the public’s expectation of future policy. An inherent problem of this approach is that the government’s action have been restricted exogenously. Evans (1990) argues that if the public’s expectations about the future policy can be influenced by current policy, it will generally be in the government’s interest to do so. Consequently, the government’s ability to precommit itself to the future policy should be determined endogenously. Moreover, how and whether such precommitment could be achieved in the first place

is naturally debatable, but it has been argued in the context of monetary policy that delegation of monetary policy to the independent authority solves the problem (Rogoff (1985)).

## 1.4 Central bank independence and credibility

In the context of monetary policy, Rogoff's (1985) suggestion of improving credibility by appointing an inflation-averse central bank gained rapid success. Some authors suggested that an independent central banker would not suffer the same myopia as elected politicians and therefore, would improve credibility and mitigate the time consistency problem. However, as pointed out by Forder (1998), there is a long way in making a case for an independent central bank from the Rogoff's theoretical results. First of all, as already pointed out by Kydland and Prescott (1977), the time inconsistency problem has nothing to do with political incentives per se, but occurs always when the policymaker discounts the future at some positive rate, the private sector has forward-looking expectations and a conflict of interest is present. This implies that any announcement of a policy rule, which deviates from that derived in the discretionary equilibrium is potentially not credible, regardless of that who did it. On the other hand, if any of the 3 presumptions cease to hold, there is no time consistency problem either, no issue of credibility and no case for an independent central bank. Although sometimes misunderstood, Rogoff's suggestion did not provide a complete solution neither to time consistency problem or credibility. It only stated that by choosing some particular preferences for the central banker, social welfare could be improved with regard to that in the discretionary equilibrium. Rogoff's main point was that an optimally inflation averse policy would find the (socially) best balance between the output stabilisation and prices in response to supply shocks.<sup>8</sup> Appointing optimally inflation averse central banker would yield lower inflation and a partial offset of supply shocks.

Rogoff's theoretical result also relies on crucial assumption that price expectations are formed by representative agent who has no effect on the aggregate behavior of the economy. Relaxing this assumption, Velasco and Guzzo (1999) show that conventional result does not need to hold

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<sup>8</sup>This trade-off has been explored also in Canzoneri (1985) and Canzoneri and Henderson (1988).

anymore. They show that if wage setters dislike inflation and internalise their effect on aggregate behavior of the economy, more risk averse central banker can actually result in welfare losses for the society. A populist central banker can maximize welfare by delivering zero inflation and the socially optimal level of employment.

Nevertheless, a large part of the enthusiasm for Rogoff's inflation-averse central banker rested on the finding of Alesina and Summers (1993) that inflation seemed to be negatively correlated with a degree of central bank independence. Since then, the number of consistent empirical and theoretical studies examining the central bank independence-inflation relationship seem to have supported earlier findings.<sup>9</sup>

However, even if we believed the empirical methodology of these studies, it does not provide a proof for the case that greater central bank independence would necessarily improve credibility. As noted by Posen (1993), the key issue for the case of independent central bank is whether a greater central bank independence is attributed to lower costs of disinflation. If we believed that during the disinflation period costly reputation building was in force, according to credibility arguments, countries with higher central bank independence should have gained reputation more quickly, thus, with lower costs in terms of output losses.

Posen (1993) and DeBelle, and Fischer (1994) could not find any evidence of this. In fact, they found evidence to the contrary.<sup>10</sup> Moreover, Cottarelli and Giannini (1997) note that for instance in New Zealand inflation fell from 16 percent to 6 percent before any change in the legislation of the central bank. Similarly, in Italy inflation fell in the 1980s from more than 20 percent to less than 5 percent, while the first legislated steps toward enhanced central bank independence were taken later. Similar evidence exists for other countries (Pollard (1993)).

There are of course several possible explanations for this failure. First, expectations of inflation are not directly related to output losses. Second, one of the 3 presumptions for the case of time consistency does not hold. Third, the central bank independence measures were biased and did not deliver a desired result. Kilponen's et. al (1992) findings give some support for the fourth possibility. Namely, it is

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<sup>9</sup>See Eijffinger and Haan (1996) for list of papers, which offer evidence on this relationship.

<sup>10</sup>Egebo & Englander (1992) and Kilponen & Sone & Sannes (1992) in the context of the European Exchange Rate Mechanism investigated possible credibility effects of membership. In both studies, results were surprisingly negative.



possible that the structure of European rigid labour markets hindered lowered inflation expectations from translating quickly enough into lower inflation, enabling unnecessarily large adverse effects in the real economy during the disinflation period. Moreover, it is clearly possible that wage setting behaviour is at least partially backward looking<sup>11</sup>, mitigating the importance of credibility as an successful inflation curb, but reinforcing the importance of labour market rigidities. Cargill (1995) and Mangano (1998) argue that because of flaws in measuring central bank independence and a high degree of subjectivity of these measures one should interpret the negative inflation-CBI relationship with great caution. Consequently, the faith that has been placed in credibility benefits through the granting of greater independence for the central bank or through reputation building seems to be in doubt. At least one should seriously look for alternative potential explanations for successful monetary policy.

This thesis concentrates, then, on the role of private sector and in particular the role of labour markets. It argues that although the legal independence of the central bank is an important step in promoting successful inflation policy, it may not be sufficient. Changing the institutional setting of the monetary policy cannot influence structural problems in the labour markets, but requires reforms in the labour markets. Chapter 2 justifies this argument by econometric analysis. It does so by using recent econometric techniques of time-series-cross-section models and builds a well-specified econometric model, which relates the central bank independence and the wage bargaining structure into inflation, nominal wage growth and unemployment in OECD countries.

## 1.5 The role of private sector

### 1.5.1 Representative agent vs. collection of agents

Representative agent models, like the monetary policy models discussed herein, have been justified by suggesting that although agents in the economy might be heterogeneous, aggregate behaviour could effectively be described by the behaviour of a representative individual. However, as demonstrated by Kirman (1992), there is no simple linkage between

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<sup>11</sup>There is in fact a plenty of evidence that wage setters are backward looking. See for instance Egebo and Englander (1992).

collective and individual behaviour. An understanding and a proper treatment of collective behaviour of possibly heterogeneous private sector is particularly important in the context of forward looking economic policy models. In the presence of conflicts and/or disparate beliefs within the private sector, the problem of anticipating the moves of both the policymaker and the other private agents is non-trivial; in such an environment the private agents' actions may have significant influence on the actions of the others and thus to equilibrium of the game itself. (Akhand (1992)).

An assumption of a representative agent, in the context of Barro-Gordon type of policy models constitutes saying that each agent has the same information, the same preferences and that each agent treats as given the actions of all the other agents. Finally, each private agent employs same forecasting rule. All this requires, inevitably, that expectations are somehow co-ordinated in the decentralised economy. This combined with the Lucas supply function, gives basically no strategic role for the private sector in present models of monetary policy. These serious limitations are noted by Cubitt (1992). First, the private sector's actions in the game have no direct affect on inflation, but merely alter the (credibility) constraints the government faces. Secondly, it eliminates the private sector's scope for precommitment, since one cannot precommit oneself to hold a particular belief at some given future date. Thirdly, it obscures the private sector's preferences about economic outcomes, since it is difficult to see how they could rationally aim for anything other than correct beliefs (Cubitt (1992)).<sup>12</sup>

In the context of monetary policy games and in an environment where the private sector has conflicting interests and/or disparate beliefs, the private sector could be assumed to have an incentive to play non-co-operative games among themselves as well as to play inflation choosing games (or wage setting games) against the policymaker(s). If these agents or collection of agents are large enough to have a significant influence on the aggregate behaviour of the economy, their interaction should be modelled in some detail. Such large agents we have in mind in this thesis are labour unions.

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<sup>12</sup>The monetary policy game models, where the full rationality assumption have been relaxed are studied for instance in Cripps (1991), Basar and Salmon (1990), Cho and Sargent (1996).

In such a framework, actions of the agents crucially depend upon perceived actions of the policymakers *as well as the other individual agents*. Properties of the equilibrium outcome of such a two-way game are likely to be different from those, which rely on the representative agent framework. For instance, as demonstrated by Phelps (1983) in the context of inflation stabilisation, it is not sufficient that the central bank persuaded each agent to reduce her private expectations of the money supply by the required amount; the prevalence of this expectation must be public knowledge and an accepted fact. This is to say that the difficulty of inflation policy is not only that of credibility and an interplay between the central bank and the private sector but it is also important that the policy enjoy commonly recognised *credence*.

### 1.5.2 Credibility vs. credence

The “commonly recognised credence of monetary policy” in the context of heterogeneous private agents substitutes “the full credibility” in the representative agent framework, while “the credence” could be thought of as a substitute for the concept of credibility. In the context of heterogeneous agents’ framework this distinction is important, since the concept of credence adds another dimension in the analysis. Credence can be associated with beliefs that the private agents have about the other private agents and their expectations of, say, inflation. In this way, the credence makes an important distinction between individuals’ own expectations and their beliefs on the others’ expectation.

Clearly, a degree of such credence is not only contingent on the institutional setting of the monetary policy, but also, depends upon institutional features of the private sector itself and their ability for coordinated actions. Fischer (1994) suggests that it makes little sense to provide for the legal independence of the central bank in countries where the law may be flouted and where financial markets are undeveloped. Similarly, different wage bargaining institutions, that have an important role in translating inflation expectations into wage inflation and back to price inflation may promote or hinder this credence of monetary policy.

### 1.5.3 Credence and wage bargaining structure

More centralised and co-ordinated wage bargaining institutions promote credence due to their better ability to co-ordinate and assess the behaviour of the others. This is because in the centralised and co-ordinated wage setting systems possibly harmful uncertainty on the actions of the others is reduced, when compared with the wage bargaining systems where several competing unions are involved. On the other hand, possibility that sufficiently centralised wage bargaining institutions use their monopoly power, may mitigate the effect of this higher credence. In the face of decentralised wage setting institutions, in turn, the monetary policy may suffer a lack of credence, but the ultimate question is, whether a lack of credence outweighs the benefit from reasonably well functioning and flexible market mechanism in wage setting. It is therefore important to note that the degree of centralisation and the degree of co-operation of wage bargaining are conceptually different issues in the context of credence. The critical point is that while the higher degree of co-ordination should inevitably promote this credence and improve macroeconomic performance, the higher degree of centralisation may work in the opposite direction. This is due to the fact that a higher degree of centralisation inevitably increases the market power of the unions.

Although, this thesis does not develop a theoretical model with “credence”, our empirical findings show that this credence may have played an important role in successful inflation policy. Namely, Chapter 2 shows empirically that a high degree of co-ordination in wage bargaining has resulted significantly lower unemployment rate and price inflation, when compared with countries without such co-operation. On the contrary, power of the unions, measured as degree of centralisation  $\times$  union density, have typically resulted higher inflation and unemployment.

This thesis emphasises an important fact that even if the policy enjoyed “commonly recognised credence”, conflicts among the private sector may still prevail. As already hinted above, wage rigidities are often structural problems and may have nothing to do with a credibility or credence as such. Chapter 3 and 4 of this thesis associate these structural problems with Keynesian type of co-ordination failure, which arises from the strategic interaction and externalities between wage setters, that have organised themselves into unions. The novelty of our analysis is that these structural problems are directly related into different wage bargaining institutions observed in the reality. This enables us to analyse an important interaction between the wage bargaining institutions and policymakers.

#### 1.5.4 Strategic role of private sector

Finally, new political economy models assume often that the private sector treats the control variables of the policymakers (policy variables) as given. This implies that the private sector treats policy variables as invariant to policy changes. As clarified by Marcellino and Salmon (1997), taking the policy variables as given in effect assumes that the private sector cannot or does not need to learn the form of the implicit policy rule. Then, as noted also by Cubitt (1992), the private sector does not play a strategic game with the policymaker at all. One way of giving the private sector a strategic role is to assume that instead of taking the policy variables as given, the private sector respond to the actual policy rule of the policymakers. This, beside of allowing precommitment of the private sector, provides an alternative way of considering the time inconsistency problem of the policymakers and yields rather different policy implications in the context of models, where the individual private agents' interaction is modelled in some detail. This is because the policymakers' policy rule enters into the private sector's decision problem in a feedback form and thus applied policy rule, or change in it, may alter the equilibrium that arises from strategic interaction between the individual private agents. The bottom line is that when deciding upon wages, each union anticipates that higher wage leads lower employment share and possibly higher inflation. The trade-off between higher wage, employment and desire of monetary or fiscal authority to accommodate too high wage, makes each wage setter to choose a wage that makes a balance between these different trade-offs, according to its preferences. Resulting equilibrium wage is therefore conditional on both wage bargaining structure and desire of policymakers to accommodate. The traditional credibility model ignores this possibility.

Consequently, Chapters 3 and 4 analyse the situation where the wage setting institutions play a strategic game against the policymakers. These Chapters show that inflationary bias is not necessarily due to the time inconsistency problem per se but due to the private agents ability to exploit the policymakers desire to accommodate. The novelty of the analysis is that aggregate behaviour of the economy can be directly related to the wage bargaining institutions and policymakers preferences.

## 1.6 Lucas supply function

The huge literature that has been developed from the Barro-Gordon (1983a,b) model has almost exclusively based on a simplified version of aggregate supply relationship

$$y_t = \alpha(\pi_t - E_{t-1}\pi_t) + \epsilon_t \quad (1.1)$$

where  $y_t$  is the deviation of output around the economy's equilibrium output in the absence of price surprises and supply shocks,  $\pi_t$  is the rate of inflation  $E_{t-1}\pi_t$  is the period  $t$  inflation rate expected as of period  $t - 1$  and  $\epsilon_t$  is a supply or productivity disturbance.

This Lucas supply function is said to be consistent with two very different interpretations. First is a market-clearing-price misperception model in which the private agents, located in spatially separated markets and endowed with only incomplete information, confuse relative and aggregate price movements (Lucas (1972, 1973, 1975), Barro (1976)). Second is a model of long-term nominal wage contracts, that are drawn up prior to the realisation of inflation with employment determined ex post along labour's marginal productivity curve (Fischer (1977), Taylor (1979,1980)). The choice between these two alternative views has been a matter of convenience.

When the Lucas supply function has been derived from a notion of long-term wage contracts, it has been generally assumed that there exists a monopoly union, who signs the wage contract before production takes place, so that workers agree to supply the amount of labour demanded by firms at the agreed wage. It is then postulated, that the market clearing wage is the same as expected inflation, leading finally to the Lucas supply function. In this vein, this literature has abstained from modelling the private economy in any detail. Instead, the private sector is represented as a reduced form relationship connecting private sector outcomes to the actions of the monetary policy maker. Moreover, the link between the policymakers preferences and those of private agents is based on a crude notion of the adverse effects of inflation, rather than a fully specified economic model.

Whilst in many circumstances (such as when one is ready to accept the monopoly union paradigm and assume that the wage contract length is one period) it is convenient to make this shortcut, acceptance of the market-clearing-price misperception model and postulating that the

market clearing wage is the same as expected inflation are conceptually not the same.

In the market-clearing-price misperception model, a form of the supply equation is justified by an appeal to Lucas and Rapping's model of labour supply and the Phillips curve. Lucas and Rapping attempted to give a new theoretical basis to the Phillips curve, that was derived from an imperfect competition paradigm in the Keynesian tradition.<sup>13</sup> Explicit reference to the paper of Lucas and Rapping (1969) is made, for instance, in Lucas (1973).

*“A supply function for labour which varies with the ratio of actual to expected prices is derived and verified empirically by Lucas and Rapping (1969)”* [Lucas, 1973, pp. 327, footnote 3].

Bull and Frydman (1983), however, show that the Lucas supply function, as it appears in Lucas (1972) cannot be rigorously derived from the Lucas and Rapping model. Bull and Frydman show that starting from the Lucas and Rapping (1969) intertemporal model of the labour supply of households the derived supply function cannot be treated as a structural equation. This is because the coefficient on the price expectation error in the Lucas supply function ( $\alpha$ ) is a function of the aggregate demand side shocks. Assumed constancy of the coefficient on the price expectation error contradicts conventional wisdom that this coefficient varies with fluctuations in inflation. Constancy of price expectation errors assumes away an important element in the inflation transmission mechanism and exaggerates the potential for the policymaker to influence output by inflicting only surprises. In this vein, it suffers from the difficulties pointed out by Lucas (1973) in his criticism of the equations in the standard econometric models of the day. Lucas (1973) goes around this problem by assuming a unit elasticity of the aggregate demand equation. In that case, the level of nominal output can be treated as an exogenous variable with respect to the product markets and the entire burden of accounting for the breakdown of nominal income into real output and price is placed on the aggregate supply side, that is, to the supply of labour.<sup>14</sup>

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<sup>13</sup>The main motivation of Lucas and Rapping (1969) was on the two divergent views about aggregate supply function that played a fundamental role in neo-classical growth theory and the short-run Keynesian-type employment theory of the time. In neo-classical growth theory the supply of labour from any fixed population was an inelastic function of the real wage, while in the Keynesian short-run literature it was commonly assumed that labour supply is infinitely elastic at some rigid real or money wage rate.

<sup>14</sup>Also Fair (1978) directly criticises the Lucas and Rapping (1969) model as being internally inconsistent. First, in the Lucas and Rapping (1969) model, the supply

More importantly, however, the stylised economy that the Lucas supply function describes is *consistent only with economies with decentralised wage setting*. Consistency with the U.S. experience was based on the empirical evidence of an insignificance of the labour unions in the U.S. economy<sup>15</sup>;

*“... Over the period covered by our study, however, at most 25 percent of the labour force was employed under collective bargaining arrangements...”*

*“... we have found neither theoretical presumption nor empirical evidence to indicate that the effect of unionism on aggregate wage rate is sizeable (or even predictable direction).”*[Lucas and Rapping, 1969, pp. 723 ].

Given these stylised facts, Lucas and Rapping (1969) ignore the possible wage setting behaviour in the economy and the supply of labour becomes all-important. However, a contrast between the U.S. and the European labour markets is well documented. Although unionisation and collective bargaining has been in decline in many countries recently, unions still play an important role in Europe. For instance, in the Netherlands union membership fell from 35% to 26% of eligible workers between 1980 and 1994, yet the share of workers covered by the terms of union contracts rose to 81% in 1994. Only in New Zealand, the United

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equation omits interest rates, although interest rates play an essential role in the utility maximisation problem of households. According to Fair (1978) the interest rate belongs to the supply equation because its justification is partially based on the appeal of intertemporal substitutions effects. Second, the supply equation excludes the initial value of assets, even though the initial value of assets affects the current supply of labour in the Lucas and Rapping model. Third, Lucas and Rapping model excludes personal tax rates from the analysis, even though it is well known that personal tax rates have an effect on the labour supply of a utility-maximising household. So, if the aggregate supply equation in the rational expectations models is to be justified on microeconomic grounds, it should not exclude the possible effects of the tax rates on aggregate supply.

<sup>15</sup>Also Phelps (1968) disagreed that the unions could explain the cost inflation phenomenon. In his 1968 paper, Phelps remarks that

*“Almost three-quarters of the civilian labour force do not belong to the unions...”*[Phelps, 1968, pp. 681].

and continues with the qualification that

*“Certainly the unions participate in the cost inflation process and they may even increase a little volume of unemployment consistent with price stability. But I should think that a union must offer its membership a frequency of employment opportunities that is roughly comparable to that elsewhere in order to thrive and that appreciably reduced employment opportunities require a greater wage differential between union and other employment that is commonly observed.”* [Phelps, 1968, pp. 681].



States, Australia and Britain have the coverage of collective bargaining and unionisation rates both fallen considerably. Only United States, Japan and Canada had both unionisation and coverage rates below 40% in 1994.

Finally, Lucas and Rapping point out explicitly that their model is not supposed to capture the behaviour of unionised economies.

*“Clearly, the model sketched above is an inaccurate view of wage and employment determination in a single, unionised industry. In such an industry, the union imposes a higher-than-competitive wage rate, limited by the labour-demand elasticity it faces and the effectiveness of its strikes. Labour supply to the industry is irrelevant, since the excess supply which must exist is not able to bid down wages. A labour market-model for such an industry will thus consist of a demand function for labour and “a wage setting equation.”*[Lucas and Rapping, 1969, pp. 723].

It seems, therefore, that the aggregate supply function when justified by an appeal of Lucas and Rapping model of labour supply is flawed in economies or industries where wages are at least partially set by the unions. Nevertheless, the view of Lucas and Rapping (1969), that the shape of the labour supply curve is all-important has been central to the widely accepted market clearing approach to labour markets. In principle, this approach postulates that at each moment the real wage and hours worked can be read off from the intersection of the supply and demand curves. The former is found by equating any real wage to the marginal disutility of work, the latter by equating any product wage to the marginal product of work. In the representative agent approach, naturally, the product and real wage are the same. More controversially, assuming that the supply curve is perfectly elastic, fluctuations in supply and demand, from whatever reason, will be entirely translated into fluctuations in hours worked while the real wage remains unaffected. Therefore, labour is always on its labour supply curve. This is in sharp contrast with Keynes, who allowed for possibility that the real wage would exceed the marginal disutility of work, permitting involuntary unemployment.<sup>16</sup>

Chapter 2 gives a detailed description of collective bargaining in

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<sup>16</sup>Moreover, as shown by Roberts (1995) most of the New-Keynesian models suggest that the Lucas Supply function is misspecified. He shows that most of the New-Keynesian models imply the following aggregate supply equation

$$y_t = \gamma(\pi_t - E_t\pi_{t+1}) + \epsilon_t \quad (1.2)$$

This implies that the policymaker cannot take inflation expectations as predetermined since the aggregate supply function contains expectations of future inflation.

OECD countries and argues that the effect of unionism on aggregate wage rate is still significant in most of the OECD countries. This effect is also quantified by new econometric evidence in Chapter 2. This new econometric evidence shows, for instance, that a dispersion in unemployment rates in OECD countries is positively related to the difference between coverage and unionisation rates and that a high degree of co-operation in wage bargaining facilities moderate unemployment rates.

## 1.7 Policy co-ordination

In most of the models in this literature policy games are simplified by the assumption of a single policymaker. This has probably arisen from several considerations. On the one hand, the central banks have historically been regarded as an integral part of a centralised policymaking process. For instance, until the mid 1970s the task of monetary policy was still largely considered to be that of balancing inflation and unemployment (Goodhart (1993)). On the other hand, the reoccurrence of the classical school, combined with the rational expectations hypothesis focused attention almost entirely on monetary policy and the issue of the central bank independence.<sup>17</sup>

Blackburn and Christensen (1989) argue, however, that as soon as monetary and fiscal management is not assumed to be under the control of a single authority, the possibility of a struggle between two powerful players exists – an independent central bank and a fiscal authority. In this setting, time consistency issues may also arise between the monetary and fiscal authority, inducing additional credibility constraints between these policymakers. Surprisingly, however, the time inconsistency problems of the fiscal and the monetary authorities have been studied almost completely separately, thus leaving these potential interactions unexplored. In other words, it may not be enough to consider propositions that reduce the credibility problem between the monetary authority and private agents alone, but it may also be necessary to consider how such propositions change the strategic interaction between the fiscal authority and the monetary authority and the fiscal authority and the private agents.

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<sup>17</sup>International policy co-ordination, instead, has been discussed in many contexts. See for instance Hughes-Hallett (1986) and Miller and Salmon (1985).

For instance Alesina and Tabellini (1987) and Jensen (1992a) have shown that when monetary and fiscal policies are not co-ordinated, a monetary regime with commitment does not necessarily improve welfare over the discretionary regime. This implies also, that the choice of the monetary regime – or any institutional reform – cannot be taken independently of the decision regarding the co-ordination of the monetary and the fiscal policy.

The monetary and fiscal authority are inherently linked through the government's budget constraint and there is actually a rather large literature on the role that fiscal policy has in determining monetary policy, in particular with respect to the impact of government deficits. Sargent and Wallace (1981), for instance, focus on the case where the time paths of both government spending and tax revenues are fixed – a situation in which it is the monetary authority that must capitulate to the fiscal authority. They pointed out that too tight a monetary policy can be inflationary, if government borrowing is sufficiently high. The same framework is equally applicable to the case where the monetary authority moves first and sets policy independently. In such a case lower rates of money growth sooner or later require lower deficits and the monetary authority may impose discipline on the fiscal authority. Given long-run constraints on deficit growth, it can also be argued that if the fiscal authority faces an independent central bank committed to anti-inflationary policy, then the expectation that deficits will not be accommodated tomorrow may deter the government from running a deficit tomorrow.

Beetsma and Boverberg (1996) study a debt accumulation problem in the monetary union with fiscal authorities and common monetary policy. They show that monetary unification boosts debt accumulation and long-run inflation if discretionary monetary policy suffers from an inflationary bias. Cottarelli and Giannini (1997) argue that a commitment to low inflation by an independent central banker may lack credibility if the announced policy ostensibly conflicts with other government policies. Indeed, most industrialised countries have not relied on credibility arguments in their fight against inflation.

Whilst it is convenient and fairly natural to assume that the monetary authority is concerned primarily with inflation, various other incentives for the fiscal authority makes sense. Beside inflation, the fiscal authority can have objectives regarding output stabilisation and some budgetary targets. There are many different approaches taken this area in past, because there are so many ways to model important aspects of the problem. However,

this should not hide the fact that fiscal and monetary authorities can have divergent preferences. The difficulty of modelling fiscal policymakers in the current framework is related to the fact that there does not exist a clear link between the policymakers and the private sectors' preferences, since the private sector has usually been modelled as a reduced form relationship describing the functioning of the economy, rather than through a fully elaborated structural model.

Chapter 3 of this thesis analyses a situation where fiscal and monetary authorities are distinct and linked through an instantaneous budget constraint. Although the model is static and ignores deficit and debt accumulation issues, the analysis puts forward an important proposition that a desirability of weight conservative central banker is conditional on the preferences of the fiscal authority on the one hand and the structure of the wage bargaining on the other hand.

## 1.8 Refinements – contracts, explicit inflation targeting and transparency

Rogoff's (1985) idea of an independent and weight conservative central banker has been further developed and made explicit in Walsh (1996) and Person and Tabellini (1993), where the government establishes an explicit incentive contract for the central bank. Another refinement is Svensson's (1997) inflation targeting approach. Legislating targeting rules or establishing independent central banks with explicit price stability goals are further examples of the type of solution, in which the incentive structure of the government has been *externally* modified or restricted. Walsh (1996) proposes imposing a penalty, such as fine, on an independent central bank for non-optimal outcome in order to eliminate the inflation bias. It works by raising the costs to the bank of generating inflation in a manner which just offsets the temptation to seek an inflation surprise to reduce unemployment. Svensson (1997) shows in a static framework that an equivalent outcome is achieved if the central bank is assumed to have a given loss function with a particular preferred rate of inflation (i.e. an explicit inflation target) below the socially preferred rate. In this case, the inflation bias of Kydland and Prescott induces a rate of inflation that is too low, so that discretionary policy brings inflation back up to the socially desired rate. If output exhibits a degree of persistence, a

state contingent linear inflation contract of Walsh can achieve the optimal policy, as can a state contingent inflation target combined with an inflation averse banker.<sup>18</sup>

When compared with the weight conservative central banker, Walsh linear inflation contract removes inflation bias, at no costs of increased output volatility. In other words, it removes the flexibility-inflation bias trade-off. The same result arises with Svensson's (1997) inflation target approach. These models also provide an explanation for the non-existent empirical relationship between a degree of independence of the central bank and output volatility. In particular, Rogoff's model predicts that an optimally inflation averse central banker would bring increased output volatility.<sup>19</sup>

In the context of explicit inflation targeting, transparency and accountability have also been emphasised. A concern for transparency is easily detectable in the countries that have introduced inflation targeting. For instance, inflation targeting central banks regularly issue so called *Inflation Reports*, explaining and motivating their policy to the general public. Briault, Haldane and King (1996) point out that revealing information on the authorities "inflation preferences" may be useful in revealing the authorities' model of how the economy works, thereby leading to greater social welfare. Explicit theoretical reference to transparency is made in Faust and Svensson (1998). They define transparency as "... *how easy it is for the public to deduce central bank intentions from observables* "[Faust and Svensson, 1998, p. 8]. On the one hand, they find that extreme transparency can be counterproductive, because the central bank loses an important constraint on its behaviour and a bad equilibrium with high inflation, and high variability of inflation and employment may result. On the other hand, extreme transparency may improve the public's ability to enforce own goals on the central bank.

Chapter 4 of this thesis extends the Svensson's (1997) explicit inflation targeting model to economy where monopolistic unions set wages. A novelty of the analysis is that the desirability of inflation targeting regime with regard to discretionary regime depends upon wage bargaining structure directly. The model also highlights an intrinsic problem

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<sup>18</sup>Explicit reference to real-world inflation targeting regimes has been discussed in Leiderman and Svensson (1995), Haldane (1995), McCallum (1996), Mishikin and Posen (1997), Cottarelli and Giannini (1997).

<sup>19</sup>For instance, Alesina and Summers (1993) did not find evidence of such a relationship.

associated with the explicit inflation targeting approach, when the wage setters have a possibility to precommit and in fact, emphasises a need to establish an inflation averse central banker together with the explicit inflation target.

## 1.9 Discussion

The theory of credibility and the advocacy of an independent central bank discussed above, still however falls some way short of making a complete case in economic theory. It has highlighted the importance of dynamic incentive constraints in policy making and made clear that economic policy can no longer be seen as “a game against nature”. As noted by Forder (1998, advocacy of an independent central bank is based on a simplified model of monetary policy and a concept of credibility that is fairly loosely linked to actual legal independence of the central banks. From the theoretical point of view, the assumptions of the basic model i.e. representative agent, single policymaker and rational expectations are obviously unrealistic, but the real question is whether these simplifications are acceptable because economic policy can be usefully constructed “as if” they were true. This thesis proposes an alternative view, where the emphasis is on the strategic role of private sector, wage setting institutions in particular, and co-ordination of monetary and fiscal policy. We argue that a lack of strategic role of the private sector and simplifying assumption of representative agent in the simple monetary models are not useful to analyse economies where the wage setting is at least partially centralized. As already discussed the theoretical part of this thesis, Chapters 3 and 4 combines a positive theory of central bank independence and collective bargaining. These developments are motivated largely by the stylised facts of collective bargaining in OECD countries and the new econometric evidence in Chapter 2 to which we now turn.



## **2 Central Bank Independence and Wage Bargaining – Econometric Evidence**

### **2.1 Introduction**

Many studies have empirically tested whether higher central bank independence is related to macroeconomic performance in OECD countries with fairly robust observation that inflation is negatively correlated with the measures of legal independence of the central bank. However, the evidence that having independent and conservative central banker is like having a free lunch, that is, an increased central bank independence has actually translated into a better credibility, is inconclusive. Different measures of central bank independence seem not to be correlated with output or employment volatility as predicted by the standard credibility model. Parkin (1987), Grilli et. al. (1991), Alesina and Summers (1993) show that higher central bank independence yields lowered inflation without costs in output. Posen (1994), Debelle and Fischer (1994), in turn, show that higher central bank independence has not translated into lowered costs of disinflation. This has been seen as a evidence against the credibility arguments. Although the inflation targeting approach has gained rapid success in practice, empirical studies of its implications are scarce. McCallum (1996) notes that for some countries the adoption of inflation targeting might have resulted higher unemployment rates.

The debate on monetary policy has somewhat ignored the role of the private sector in successful monetary policy and inflation control, although there exists another line of inquiry where the private sector's behaviour, the management of wage setting in particular, has been seen as a major



element in successful economic policy. This literature builds on Bruno and Sachs (1985), Cameron (1984), Calmfors (1982,1985, 1988), Crouch (1985), Freeman(1988), Lindbeck and Snower (1989), Pohjola (1987) and Soskice (1990).<sup>20</sup>

Instead of the government “tying its hands” in economic policies, as suggested in the standard credibility literature, this literature suggests that flexible full employment policies are crucial in facilitating a co-operation between labour and capital.

Bruno and Sachs (1985) suggests that the relationship between centralisation of wage bargaining, unemployment performance and wage restraint is positive and linear, implying that a more centralised wage setting system would yield a superior macroeconomic performance. In contrast, Calmfors and Driffill (1988) and Freeman (1988) demonstrate that extremes perform the best. In other words, either a highly centralised system with national bargaining or a highly decentralised system with a wage setting at the level of individual firms perform better than with and an industry level bargaining structure.

Empirical evidence on the role of wage bargaining is inconclusive. Early analysis found a positive relationship between a country’s economic performance, measured by a misery index, and its degree of corporatism (Bruno & Sachs (1985), Cameron (1984), Crouch (1985)). Calmfors and Driffill (1988) found evidence of a hump-shaped relationship between economic performance and centralisation in the 1974-1985 period. More recent empirical evidence, however, has produced rather mixed results (Traxler (1994), Scarpetta (1996), OECD (1997)).

As already discussed in Chapter 1, the basic argument is that a successful inflation policy might be conditional on both monetary and labour market institutions. Some attempts have been made to combine the debate on the centralisation of wage bargaining and central bank independence. (See for instance Akhand (1992), Bleaney (1996), Cubitt (1993), Cukierman and Lippi (1998), Iversen (1998), Skott (1995) and Velasco and Guzzo (1998)). Empirical studies, which combine these different aspects are however scarce. Bleaney (1996) argues theoretically that inflation performance should not depend upon the characteristics of wage bargaining, but only on the monetary regime and central bank

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<sup>20</sup>Another recently revived branch of the labour literature concentrates on an interaction between specific aspects of labour legislation, such as minimum wages, firing and hiring costs, labour mobility costs and unemployment benefits, and employment (the so-called rigidity vs. flexibility debate). See for instance Bertola and Ichino (1995).

independence, while unemployment should depend both on the central bank independence and the wage bargaining structure. However, Akhand (1992), Cubitt (1993) and Skott (1995) show that inflation performance should also be conditional on the wage bargaining structure. Skott (1995) also shows that if also the unions are inflation averse, countries may perform well despite a central bank's concern on output. Bleaney (1996) and Iversen (1998) have tested empirically some of the implications of this literature. While Bleaney (1996) confirms his theoretical findings, Iversen (1998) shows that unemployment performance depends upon degree of discretion of monetary policy as well as the degree of centralisation of wage bargaining. Cukierman and Lippi (1998) suggest that when central bank independence is moderate, there is a clear hump-shaped relationship between unemployment and centralisation of wage bargaining. Their evidence also shows that the inflation-reducing impact of central bank independence is largest when centralisation of wage bargaining is at its intermediate level.

Regardless of the lack of conclusive evidence on how central bank independence and wage bargaining interacts at the aggregate level, both of these literatures have been influential. This is evident from the fact that the two most visible institutional developments during 1980s and 1990s have been associated with central banking and wage bargaining. Many OECD countries have significantly altered the legal framework within which their central bank operates, while at the same time many OECD countries have significantly altered the methods of wage bargaining. The revision of the legal framework of central banks has basically implied a more precise definition of the central bank's mission, a considerable widening of the degree of independence of the central banks and a greater emphasis on the means and forms of accountability. The revision in wage bargaining structures, in turn, has implied either a greater emphasis on market forces and a move to firm level bargaining or, somewhat paradoxically, a greater emphasis on co-ordinated and centralised wage bargaining, the former being perhaps more common. In many countries labour law has also been changed considerably, with emphasis on increased flexibility.

This Chapter makes another attempt to assess empirically importance of these issues on the macroeconomic performance of OECD countries. We estimate a cross-section-time-series model for inflation, nominal wage growth and unemployment for the period of 1973–1996. Sections 2–5 discuss the measurement of central bank independence and labour market structure. In particular, the problems that are associated with the

measures used in the current literature will be highlighted. Instead of using an overall measure of central bank independence, we consider political independence, personnel independence, importance of the price stability objective in the statute of the central bank and the financial independence. We have also updated these Cukierman's (1992) indices following recent changes in central bank laws and the adoption of inflation targeting. With regard to wage bargaining, we use a recently published dataset on wage bargaining structure, as presented in OECD (1997). In particular, as suggested by Golden (1993), we separate between the co-ordination and formal centralisation of wage bargaining. Moreover, we construct a new measure of union power, which combine formal centralisation and density and consider the implications of large differences that can be seen between the coverage and unionisation rates in some countries. Section 7 highlights important reforms in central banking and labor markets and sections 8-9 finally discusses the setup of the econometric model and interprets the results. Section 10 concludes. Finally, appendix A discusses in detail the econometric methodology of estimation and highlights some intrinsic problems associated with the estimation and specification testing of our model.

## 2.2 Central bank independence

### 2.2.1 Definition and a measurement of legal independence

According to Friedman (1962), central bank autonomy refers to the relation between the central bank and the government that is comparable with that between the judiciary and the government. The judiciary can rule only on the basis of laws provided by the legislature and it can be forced to rule differently only through a change in the law. Therefore, central bank autonomy can and should be guaranteed by law.

According to Hasse (1990) central bank independence relates to three areas in which the influence of government must be either excluded or cushioned. Those prominent areas are *independence in personnel matters, financial independence, and independence with respect to policy*. Personnel independence refers to the influence the government has in the appointment procedures of the governing board of the central bank.

Financial independence refers to the limitations on lending from the bank to the public. Policy independence refers to the manoeuvring room given to the central bank in the formulation and execution of monetary policy. The policy independence can be further classified according to goal and instrument independence, as suggested by Debelle and Fischer (1994) (Eijffinger and De Haan (1996)).

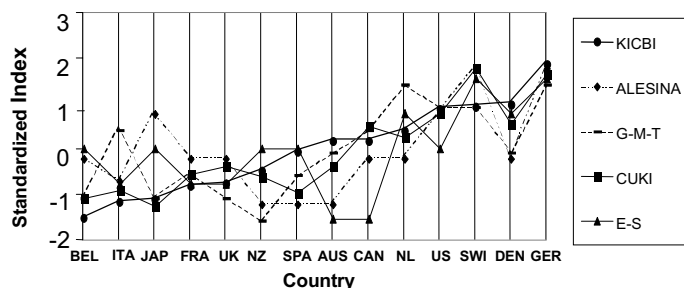
The measurement of central bank independence creates both conceptual and empirical problem, however. Existing indices of central bank independence are often incomplete and noisy indicators of actual independence and subject to subjectivity bias, as noted by Mangano (1998). It should be acknowledged that existing summary indices of legal independence of the central banks, such as Cukierman's LVAU index, might not provide an objective measure of actual central bank independence. For instance, when studying a link between the central bank independence and the budget deficits, the most important factor is financial independence. When judging the relationship between inflation and central bank independence, the political independence may play the most important role. Often a lack of, say, goal independence and personnel independence has been supplemented by the instrument independence, as in the case of New Zealand and other inflation targeting countries (Eijffinger and de Haan (1996)). Sometimes, a lack of, say, financial independence may mitigate the political independence as in the case of the Bank of Italy. Therefore, in empirical analysis, one should control for the different forms of legal independence and not to use only the highly aggregated summary measures of legal independence.

Most of the existing attempts at the systematic characterisation of central bank independence and empirical studies rely on legal aspects of independence, such as Alesina (1993), Grilli, Masciandro and Tabellini (1991), Cukierman (1992) and Eijffinger-Schaling (1995). The concept of independence used also in our empirical analysis proxies the legal independence that is considered to be an essential component of actual independence. The legal independence inherently suggests what is the degree of independence that legislators meant to confer on central bank. (Cukierman (1992)).

Table 2.1 shows some summary indices of the central bank independence that have been used in the recent literature. Comparison between different indices is a fairly difficult task due to the different methods of assessing independence of the central banks. While Alesina, Grilli et.al. and Eijffinger and Schaling use a rather crude measure,

Cukierman's and modified index of Cukierman developed in this paper (KICBI), facilitate ranking of the countries in more detail. In order to facilitate graphical comparison, we have standardised different indices in figure 2.1 and ranked them according to KICBI index. Moreover, we have calculated Spearman's rank correlation between Cukierman's and our own index as well as between Alesina, Eijffinger and Schaling and Grilli et.al.

Figure 2.1. **Comparison between Different Indices of Legal Independence of Central Bank**



Notes: Standardized indices refer to the period of 1980-1989. Austria, Finland, Norway, Sweden, Greece and Portugal were excluded from comparison because of lack of available data. Countries were ranked according to KICBI index from the least independent to the most independent. G-M-T refers to political independence of their index.

Figure 2.1. shows fairly substantial differences between the ranking of countries according to different indices. However, rank correlations in table 2.2 show that indices are highly correlated. Differences are due to the differences in measurement methods as well due to the high subjectivity in the assessment of central bank laws. For instance, Grilli et.al. assesses the (political) independence of the Reserve Bank of New Zealand as the least independent, while Cukierman and our own index ranks the RBNZ as having a medium independence. Different indices seem to agree relatively well between the central banks, that have been ranked the most independent, such as US, Switzerland and Germany.

Mangano (1998) argues that Cukierman's (1992) index suffers a rather large subjectivity bias with regard to Grilli et. al. index. This subjectivity bias is judged by comparing the values attributed on common legal characteristics of central banks by Grilli et. al. and Cukierman. In general, Mangano finds that Cukierman and Grilli et. al. disagree nearly 60% of countries when deciding whether the central bank is legally allowed to purchase government debts in the primary markets or not. Virtually a third of the values attributed to their common criteria seem to be subject to conflicting interpretations. In addition, as noted by Eijffinger and de Haan (1996), Cukierman attributes an incorrect value to five out of the 16 characteristics by which he measures the legal independence of the Dutch central bank. However, Cukierman's index contains the largest set of countries and is perhaps the most comprehensive attempt to assess legal independence. For instance, Grilli et. al. index excludes all the Scandinavian countries, that are of substantial interest in our study and separates a form of independence only into two categories; financial and economic independence.

Table 2.1. **Spearman Rank Correlations**

Index	KICBI	E-S	ALESINA
CUKI	0.90	-	-
G-M-T	-	0.88	0.89
E-S	-	-	0.96

Notes: Spearman's rank correlation is calculated between those indices which were closely comparable. KICBI and CUKI ranked the countries with a larger scale, while ALESINA, G-M-T and E-S used the scale that was significantly smaller.

Table 2.2. **Inflation Targeting and Indices of Central Bank Independence**

Country	Alesina	G-M-T	E-S	CUKI	KICBI
Australia	1	9, 3	1	.31	.36
Austria	-	9, 3	3	.58	.59
Belgium	2	7, 1	3	.19	.07 (.34)
Canada*	2	11, 4	1	.46	.36
Denmark	2	8, 3	4	.47	..0
Finland*	2	-	3	.27	.28
France	2	7, 2	2	.28	.19 (.66)
Germany	4	13, 6	5	.66	.65
Greece	-	4, 2	-	.51	.54 (.62)
Ireland	-	7, 3	-	.39	.60
Italy <sup>(a)</sup>	1.5	5, 4	2	.22	.13 (.33)
Japan	3	6, 1	3	.16	.14
Netherlands	2	10, 6	4	.42	.40 (.30)
New Zealand*	1	3, 0	3	.27	.25 (.30)
Norway	2	-	2	.14	.15
Portugal	-	3, 1	2	-	-
Spain*	1	5, 2	3	.21	.32 (.64)
Sweden*	2	-	2	.27	.26 (.44)
Switzerland	4	12, 5	5	.68	.49
United Kingdom*	2	6, 1	2	.31	.20
United States	3	12, 5	3	.51	.48

Notes: Alesina refers to Alesina (1993). G-M-T refers to Grilli, Masciandro, Tabellini (1991). The first figure is their index of economic independence and the second political independence. E-S refers to Eijffinger-Schaling (1995), CUKI refers to Cukierman (1992) and to an unweighted index of legal independence of the central banks (LVAU). \* indicates the countries with an explicit inflation targeting regime at the end of 1996. The first 4 indices refer to the period of 1980-89. Construction of the CUKI and KICBI indices have been explained in appendix B. The first figure in the last column refers to 1980s and the last to 1996. a) The first figure in KICBI refers to the situation before the divorce between the Treasury and the Bank of Italy in 1981. Otherwise the first figure refers to 1985. If there is one figure only, there has not been a change in the statute of the central bank. b) Value in brackets refers to the original Cukierman (1992) index, while a value without brackets refer to one reported in Eijffinger and De Haan (1996). The former was used in the empirical analysis.

Consequently, although the indices of legal aspects of central bank independence and their coding used in our empirical analysis are based closely on Cukierman's (1992) indices, our measure of financial independence differs from Cukierman (1992). We also account for the adoption of inflation targeting, by constructing a dummy for those countries that adopted inflation targeting, as well as for the recent changes in central bank laws. Corresponding changes and their effect on the legal independence are explained in appendix B table B.3. Table 2.2. summarises effects of those changes on an overall legal independence of the central banks and highlights the countries that have adopted explicit inflation targets towards the end of 1996 (\*). This allows us to extend the time period until 1996 and study the effects of these important changes on macroeconomic performance. The time periods considered in this study cover 3 different periods, 1972–1979, 1980–1989, and 1990–1996, so that the legal variables of the central bank independence are coded separately for each subperiod. We have also reassessed the independence of the Dutch Central bank and corrected the values following Eijffinger and de Haan.

From table 2.2 it can be seen that the legal independence of the central banks in those countries that adopted changes has increased. Table 2.2 also highlights that inflation targeting countries have traditionally had limited independence. On the contrary, countries that continued with monetary targeting, such as Germany, United States and Switzerland have had the most independent central banks historically. Belgium, France, Greece, Italy, New Zealand, Spain and Sweden have assigned more independence to their central banks recently. When we add the countries which adopted inflation targeting, 10 out of 20 countries have changed their monetary regime since the 1980s.

## 2.3 Different forms of legal independence

### 2.3.1 Measurement

Cukierman's indices are based on a limited number of relatively precise legal characteristics and a code of independence is assigned to each central bank for each characteristic. Different legal variables, altogether 16, are coded using a uniform scale ranging between 0 to 1, from smallest level of



independence to highest level of independence respectively. The number of independence levels varies across legal variables depending on the fines of data on alternative legal characteristics. These legal characteristics are then divided into four groups with abbreviations PERI, POLI, OBJE, FINI respectively.<sup>21</sup>

- Variables concerning the appointment, dismissal and term of office of the chief executive officer of the bank (personnel independence (PERI)).
- Variables concerning the resolution of conflicts between the executive branch and the central bank and the degree of participation of the central bank in the formulation of monetary policy and budgetary process. (political independence (POLI)).
- Final objectives of the central bank as stated in its charter (importance of price objective in the status of the central bank (OBJE)).
- Legal restrictions on the ability of the public sector to borrow from the central bank (financial independence (FINI)).

Central banks in which the legal term of office is longer and in which the executive branch has little legal authority in the appointment or dismissal of the governor are classified as more independent. This classification refers to personnel independence of the central bank. Central banks with wider authority to formulate monetary policy and to resist the executive branch in cases of conflict are classified as more independent. This refers to policy independence. Similarly, central banks in which the only or main objective of policy is price stability are classified as being more independent, than central banks with a large number of objectives or banks in whose charter price stability is not mentioned as an objective at all. *The price stability objective could be seen as a measure of “conservative bias” of the central bank in Rogoff’s terminology.* Central banks in which the limitation on lending from the bank to the public is limited are considered as having more financial independence. In Cukierman’s original index these limitations encompass a number of more detailed variables, but we have chosen to use only one such variable to

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<sup>21</sup>The coding of these legal characteristics and their aggregation is explained in Appendix B.

proxy financial independence. According to this variable, central banks which are not allowed to give advances for the government or when advances are subject to restrictions are considered to have more financial independence.

Restricting the influence of the government in appointment procedures, increasing financial independence, and decreasing policy dependence has a same goal; to improve the credibility of the policy by restricting the discretionary power of the government and to restrict discretionary short-term influence of the government on the conduct of monetary policy. According to Cottarelli and Giannini (1997) the key to success in fighting inflation is to put in place some arrangement so that the private sector believes that the instrument flexibility left to the monetary authorities will not be used to exploit the short-run trade-off between inflation and output. OECD countries have adopted different means to achieve this goal as will be discussed briefly below.

### 2.3.2 Examples of different practices

The Reserve Bank of New Zealand (RBNZ) has an explicit inflation target that is precisely described in a contract with the government. The governor of the central bank can be dismissed if (s)he fails to deliver the inflation target. According to the Central Bank Law the appointment of the central bank governor is made by the finance minister and the deputy governor of the central bank is appointed by the board on the recommendation of the governor. Therefore, according to the classification given in the literature, the RBNZ does not have any goal independence, very low personnel independence, but *full instrument independence*, which is supposed to provide full credibility of the price stability objective. Limited legal independence is therefore, substituted by instrument independence. According to Alesina (1988), Grilli, Masciandro, Tabellini (1991) and Cukierman (1992) classification, the RBNZ has very limited legal independence. According to Eijffinger and Schaling (1992) classification, the RBNZ has more than limited independence.

Australia, Canada, Finland, Spain, the U.K., and Sweden have recently introduced inflation targets, such that these countries could be treated as explicit inflation targeting countries with almost full instrument independence. The emphasis in an explicit inflation targeting regime is on accountability and transparency, in the aim of achieving

credibility through public monitoring. An explicit inflation targeting regime, therefore, does not constitute solely an announcement, but the announcement of an targeted inflation path extending to few years ahead, coupled with setting up of public monitoring procedures.

Current characterisations of central bank independence, as discussed above, fail to capture this form of instrument independence. Therefore, we proxy the full instrument independence by constructing a dummy for the countries that adopted inflation targeting. This dummy variables takes value 1 in a case where the country has adopted inflation targeting and is set to zero otherwise.

In Germany, the government can suspend decisions of the Bundesbank for a maximum of two weeks and the Bundesbank can be overruled through a change in the legislature by a simple majority in parliament. The Bundesbank has an obligation to offer general support to the government's economic policy in instances in which this support does not prejudice the primary objectives of price stability. Contrary to the RBNZ the Bundesbank has no obligation to agree, obey, or announce any targets for inflation. The Bundesbank is, therefore, independent of any instruction from the government; according to the Bundesbank law 1957, government representatives have the right to attend meetings of the Central Bank Council, but not to vote. Therefore, the Bundesbank is provided with almost full policy independence, although the central bank policy has to ultimately enjoy confidence of the parliament. According to all indices used in the literature, the Bundesbank has been considered the most independent central bank within industrialised countries.

Until the beginning of 1980s, the financial independence of the Bank of Italy was drastically limited by a law which explicitly stated that the Bank of Italy had to hold government issued bonds. Financial independence of the Bank of Italy was lacking, since the government had basically direct access to central bank credits implying that the monetary policy was subordinated to fiscal policy. In 1981, the so called divorce between Bank of Italy and the Treasury occurred with new Act. Direct access to central bank credit was limited in order to discipline the fiscal authorities building a large budget deficit. Alesina (1993), Eijffinger and Schaling (1993) and Cukierman (1992) consider the Bank of Italy as having a very limited legal independence, while Grilli et. al. consider the Bank of Italy as having a medium independence.

### 2.3.3 Comparison between different forms of central bank independence

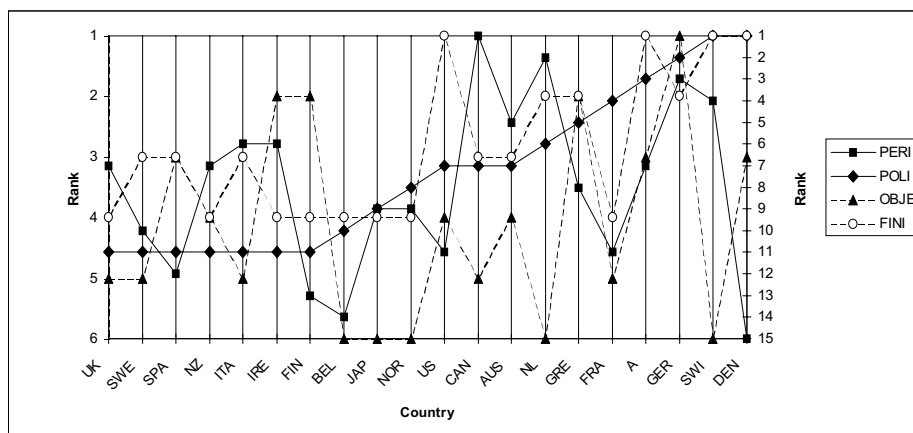
Given that OECD countries have adopted different practices in securing the legal independence of their central banks, it is interesting compare these different forms of independence according to our measures. We have therefore ranked the countries according to each political independence, personnel independence, financial independence and importance of price objective in the status of the central banks and produced a Spearman rank correlation between different forms of independence during 1980-1989 and 1990-1996. Apparently, also these indices capture substantial differences in the ranking of the countries according to different forms of independence. This is evident from figure 2.2 and table 2.3 below. Figure 2.2 reveals that some forms of legal independence are relatively loosely linked to each others. This loose link is also quantified in table 2.3 by rank correlations. In general, while the financial independence and the importance of price objective in the status of the central bank seem to be closely related, policy independence and financial independence are very loosely linked. It is also interesting to note that for instance the Danish central bank seems to have very high political and financial independence, while no personnel independence. A similar kind of substantial differences appear also in the case of Canada, the Netherlands and Finland. On the contrary, the Bundesbank is ranked as having a very high independence according to all variables.

Table 2.3. **Spearman Rank Correlation between Different Forms of Legal Independence**

Index	PERI	POLI	OBJE	FINI
PERI	1			
POLI	0.66 (0.65)	1		
OBJE	0.50 (0.48)	0.64 (0.72)	1	
FINI	0.38 (0.32)	0.05 (0.28)	0.93 (0.89)	1

Notes: Values in brackets refer to year 1996 and values without brackets to the period of 1980–1989.

Figure 2.2. **Comparison between Different Forms of Independence during 1980–1989**



Notes: Countries have been ranked according to policy independence (POLI) variable from the least independent to the most independent. The right hand side scale refers to the scale of PERI and POLI and the left hand side to the scale of OBJE and FINI. The time period is 1980–1989.

## 2.4 Recent changes in monetary regimes

### 2.4.1 Inflation targeting

During the 1990s a number of countries adopted a monetary policy framework centred on explicit inflation targets. Such a framework was first adopted in New Zealand in 1990, under the Policy Targets Agreement. This was followed in 1989 by the Reserve Bank of New Zealand Act, which established a statutory commitment to price stability. Canada followed in February 1991 by introducing inflation-reduction targets, in a joint declaration by the Bank of Canada and the Canadian government. The United Kingdom turned to inflation targeting in October 1992 after the collapse of ERM exchange rate band in September 1992. Similarly, the Riksbank of Sweden announced explicit inflation targets in January 1993 following the dramatic breakdown of the currency target zone in November 1992. Finland followed shortly after in February 1993, again

after the breakdown of the currency peg in September 1992. Australia introduced an inflation target in April 1993, Mexico in September 1994 and Spain in summer 1994. Typically, those countries that adopted inflation targeting regimes have been characterised by a lack of legislative independence of the central bank prior to the monetary reforms.<sup>22</sup>

## 2.4.2 Increased legal independence

A number of countries have also recently made substantial changes to their Central Bank Laws. From table B in appendix B, we can see that Belgium, France, Greece, Italy, New Zealand, Spain and Sweden have increased the legal independence of their central banks in various ways. In Greece, Belgium, France, Italy and Spain, the central banks were freed from obligation to finance either the government or government-controlled bodies. In France, Italy, New Zealand and Spain, the central bank objectives were clarified and maintenance of price stability or monetary stability was set as the main goal of these central banks. A number of these recent changes were clearly related to satisfying the requirements of the Maastrich Treaty.<sup>23</sup>

## 2.5 Wage bargaining

### 2.5.1 Introduction

At the beginning of the 1980s, a vast political economy literature concentrated on the macroeconomic consequences of various wage-bargaining systems. It was thought that wage bargaining structure could explain part of the dispersion of macroeconomic performance in advanced industrialised countries. In particular, some wage bargaining systems were seen to have higher wage restraint. Many economists and policymakers were puzzled by the continuously decreasing employment rates in Europe in contrast with the relatively steady and high employment rates in the U.S.

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<sup>22</sup>For more detailed description and discussion see for instance McCallum (1996).

<sup>23</sup>During the 1997 also Finland and the U.K modified their central bank laws according to the Maastrich treaty. Indices here do not capture these effects since the new law was only passed through the parliament during 1998.

One of the starting points of this literature was in Bruno & Sachs (1985) who argued that

*“A real wage moderation is a key to achieving low inflation and low unemployment after a supply shocks. In countries with near-universal union coverage and highly centralised negotiations (for example Austria and Sweden) it seems that wages were kept closer to market clearing levels than in more decentralised systems (such as the United Kingdom)”*

That is, the relationship between centralisation, unemployment performance and wage restraint seemed to be linear, implying that a more centralised wage setting system would yield a superior macroeconomic performance.

In contrast, Calmfors and Driffill (1988) and Freeman (1988) demonstrated that extremes perform the best. In other words, either a highly centralised system with a national bargaining or a highly decentralised systems with a wage setting at the level of individual firms perform better than those with an industry level bargaining structure. Calmfors (1988) explained this by the idea of Olson (1965) who stated that an organised interest may be most harmful when they are strong enough to cause major disruptions but not sufficiently encompassing to bear any significant fraction of the costs for society of their actions in their own interest.

The first view emphasises the fact that a high degree of centralisation guarantees that wage setters recognise broader interests. According to this line of argument, corporatist success in improving country’s economic performance is driven by union officials, who in response to a government pressure, agree wage-contracts that do not reflect the preferences of the average union member. Workers are unable to resist wage moderation, because national union leadership has successfully insulated itself from union members. According to this view, institutional arrangements exist to overcome various market failures and may therefore benefit economic performance.

This view has been criticised by the insider-outsider view, according to which union officials may not bear enough concern on outsiders. This mitigates the possibility of union officials to “recognise a broader interest” (For instance Lindbeck and Snower (1988)). The second view emphasises a role of market forces (competition) in securing the optimal combination of real wage and employment. In contrast to first view, non-market institutions are “rigidities” which only harm economic performance.

## 2.5.2 Co-ordination and centralization – alternative interpretations

The Calmfors-Driffill hypothesis supported the view that the degree of centralization of union power is the central attribute that determines union behaviour and its impact on the national economy. Calmfors and Driffill (1988) constructed an index of centralization by assessing the co-ordination level within national union confederations and within national employer organisations and the existence of parallel central organisations and their co-operation. Centralisation is then, in fact, defined and measured by the extent of co-operation between different unions and employer organisations in wage bargaining.

However, Golden (1993) emphasises the coercive authority of central confederations over its affiliates (unions). The degree of centralization and the level at which bargaining predominantly takes place depends on the institutional conditions such as the extent to which national confederations (peak organisations) have coercive authority over its affiliates. The coercive authority appear as the extent to which the peak organisations are able to set wage demands, sanction strikes action and generally disperse union resources. The difference between Golden's definition and Calmfors and Driffill's definition is that she defines centralization as the formal centralization of authority between unions and their peak organisations, while Calmfors and Driffill considered centralization from a broader perspective, combining formal centralization and co-operation.

The basic insight of Golden's (1993) analysis is that the centralization of the authority may not be enough to secure sustained wage moderation and better economic performance. This is because the binding/coercive authority that central confederations hold over their affiliates is ultimately voluntary and thus this authority is more likely to rest on bargaining and agreement among the parties. According to the OECD (1997) report, the fact that in highly centralised wage bargaining countries wages tend to drift supports this argument. Because the extent of co-ordination and formal authority are separate independent features of wage bargaining and may evolve in a different direction over time, it may not be appropriate to combine these under the same heading, as in the Calmfors and Driffill index.

Given this conceptual difficulty with defining centralization, Golden (1993) argues that a lack of co-operation that is potentially harmful for the aggregate economy can be solved even without the formal authority



of confederations, provided that institutional conditions facilitate the co-ordination of bargaining strategies among unions. This view, primarily due to the Lange (1984) and Wallerstein (1990), emphasises the collective action problem affecting union behaviour. According to this line of argument co-operation among workers and among unions may be difficult to achieve, because of free riding problems. The idea is that even if workers and unions collectively prefer wage restraint, it is in no individual worker's or union's interest to do so. This idea has been formalised for instance in monopolistic competition models.

The possibility for co-ordination, in turn, is likely to rest on two factors:

(i) The number of national-level actors involved in the wage setting process.

(ii) The degree of competition among them.

The first indicates the "unconditional likelihood that labour is able to overcome internal co-ordination problems and the second the likelihood that it resolves internal distributional conflicts. When the number of unions that participate in the wage bargaining is small, unions can monitor and assess their own and each other's behaviour in the bargaining process, thus reducing the uncertainties that can be harmful in the wage bargaining process. The second refers to the fact, that not all union problems are simply co-ordination problems that can be eased by reducing the number of actors involved; Inter- and intra union relations are characterised by genuine conflicts of interest as well. The problem of competition can be eased by demarcating nonoverlapping union territories and thus, reducing the competition from members. According to Golden (1993) these together should moderate wage demands, reduce inflationary pressure and help to maintain high employment.

### 2.5.3 Credence and wage bargaining structure

As already argued in Chapter 1, more centralised and co-ordinated wage bargaining institutions promote credence of monetary policy due to their better ability to co-ordinate and assess the behaviour of the others. This is because in the centralised and co-ordinated wage setting systems uncertainty on the actions of the others is reduced, when compared with the wage bargaining systems where several competing unions are involved. On the other hand, possibility that sufficiently centralised wage

bargaining institutions use their monopoly power, leading to higher wage inflation, may mitigate the effect of this higher credence. In the face of decentralised wage setting institutions, in turn, the monetary policy may suffer a lack of credence, but the ultimate question is, whether a lack of credence outweighs the benefit from reasonably well functioning and flexible market mechanism in wage setting. It is therefore important to note that the degree of centralization and the degree of co-operation of wage bargaining are conceptually different issues in the context of credence aswell. The critical point is that while the higher degree of co-ordination should inevitably promote this credence and improve macroeconomic performance, the higher degree of centralization may work in the opposite direction. This is due to the fact that a higher degree of centralization inevitably increases the market power of the unions.

Also Golden (1993) refers to this same phenomenon by “visibility”, which inherently decreases uncertainties about the actions of the other wage setters in the wage bargaining process. However, Golden (1993) does not notice that an increased centralization may lead higher wages, due to the exploitation of market power. We turn to this after considering the measurement of co-ordination and centralization of wage bargaining.

Table 2.4. **Centralization and Coordination of Wage Bargaining**

Country	Centralization			Co-ordination			$\Delta$	
	80	90	94	80	90	94	CE	CO
Australia	2.25	2.25	1.50	2.25	2.25	1.50	↓	↓
Austria	2.25	2.25	2.25	3.00	3.00	3.00	→	→
Belgium	2.25	2.25	2.25	2.00	2.00	2.00	→	→
Canada	1.00	1.00	1.00	1.00	1.00	1.00	→	→
Denmark	2.25	2.00	2.00	2.50	2.25	2.25	↓	↓
Finland	2.50	2.25	2.25	2.25	2.25	2.25	↓	→
France	2.00	2.00	2.00	1.75	2.00	2.00	→	↑
Germany	2.00	2.00	2.00	3.00	3.00	3.00	→	→
Italy	1.75	2.00	2.00	1.50	1.50	2.50	↑	↑
Japan	1.00	1.00	1.00	3.00	3.00	3.00	→	→
Netherlands	2.00	2.00	2.00	2.00	2.00	2.00	→	→
New Zealand	2.00	1.50	1.00	1.50	1.00	1.00	↓	↓
Norway	2.00	2.25	2.25	2.50	2.50	2.50	↑	→
Portugal	2.00	2.25	2.00	2.00	1.75	2.00	↑	↑
Spain	2.25	2.00	2.00	2.00	2.00	2.00	↓	↓
Sweden	3.00	2.25	2.00	2.50	2.25	2.00	↓	↓
Switzerland	2.00	2.00	2.00	2.25	2.25	2.25	→	→
the U.K	2.00	1.75	1.50	1.50	1.25	1.00	↓	↓
U.S.	1.00	1.00	1.00	1.00	1.00	1.00	→	→

Source: OECD (1994,1997).

Notes: Centralization and co-operation figures are based on OECD secretariat estimates of prominent bargaining level and the degree of co-ordination. Co-ordination includes both union and employer co-ordination. A value of 1 in each characteristic is assigned to the decentralised/uncoordinated system and a value of 3 for the centralised/ co-ordinated wage bargaining system. The last column then gives direction of change in centralization (CE) and co-ordination (CO) of wage bargaining during 1980–1994, (→) indicates no change, (↓) decentralization and (↑) centralization/co-ordination.

#### 2.5.4 Co-ordination and centralization – measurement

Unfortunately, there does not exist a simple or even comprehensive combination of measures that would account for all these factors. The best available source for the data is OECD (1997), where the Calmfors-Driffill (1988) index has been extended. OECD (1997) evaluates the degree of formal centralization in wage bargaining separately from co-ordination. Table 2.4 below reproduces these figures.

From table 2.4 we can see that the degree of centralization and co-operation are quite closely related. However, interesting exceptions are those where the degree of centralization has been higher than the degree of coordination. This was the case in Belgium, Finland, France, Italy, New Zealand, Spain, Sweden and the U.K. during the 1980s, while the situation remained similar only in the U.K in 1994. These countries may represent the most unfavourable bargaining systems, since in these countries the market power of the unions has been considerable, while the likelihood for inter- and intra union conflicts of interest perhaps the greatest. In all other countries, the degree of co-operation has been at least as large as the degree of centralization. The difference between centralization and co-operation is particularly large in Austria, Germany and Japan. In those countries industry level or decentralised wage bargaining systems seem to be characterized by genuine co-operation. We should expect this to improve the performance of these systems.

#### 2.5.5 Union monopoly

Ultimately wage bargaining is a process of decision making between the parties representing employer and employee interests. The key element in the decision making process between union and employer is the ability of both sides to halt production. The firm's power depends on the right to lock-out or fire, while the union's power depends on the right to organize and strike. Formally, the external power of the unions and confederations is upheld by a statute and therefore it is more than likely that institutional conditions play a dominant role in the wage setting game between the firms and unions ( Jackman (1991)).

Jackman et. al. (1991) have analyzed the issue in a simple model of bargaining between unions and firms. Under reasonable assumptions, the rise in union power leads to relative wage increases and a fall in aggregate

employment. An increase in union coverage increases union employment and total employment rises. However, if the supply in the competitive sector is elastic enough, a rise in union coverage depresses the competitive sector wages and leads to fall in employment. This result is increasingly likely the nearer one is to complete unionization. *In general, over most relevant ranges an increase in coverage reduces total employment.*

Table 2.5. **Density and Coverage Rates in OECD Countries**

Country	Union Density <sup>a</sup>				Bargaining Coverage <sup>b</sup>			
	70	80	90	94	70	80	90	94
Australia	.47	.48	.41	.35	—	.88	.80	.80
Austria	.57	.56	.46	.42	—	.98	.98	.98
Belgium	.52	.56	.51	.54	—	.90	.90	.90
Canada	.32	.36	.36	.38	—	.37	.38	.38
Denmark <sup>b</sup>	.68	.76	.71	.76	—	.69	.69	.69
Finland	.66	.70	.72	.81	—	.95	.95	.95
France	.22	.18	.10	.09	—	.85	.92	.95
Germany	.34	.36	.33	.29	—	.91	.90	.92
Italy	.44	.49	.39	.39	—	.85	.83	.82
Japan	.34	.31	.25	.24	—	.28	.23	.21
Netherlands	.36	.35	.26	.26	—	.76	.71	.81
New Zealand	—	.56	.45	.30	—	.67	.67	.31
Norway	.52	.57	.56	.58	—	.75	.75	.74
Portugal	.61	.61	.32	.32	—	.70	.79	.71
Spain <sup>c</sup>	.27	.09	.13	.19	—	.76	.76	.78
Sweden	.73	.80	.83	.91	—	.86	.86	.89
Switzerland	.32	.31	.27	.27	—	.53	.53	.50
the U.K.	.48	.50	.39	.34	—	.70	.47	.47
U.S.	.26	.22	.16	.16	—	.26	.18	.18

Source: OECD (1997, Table 3.3, p. 71)

Notes. a) The latest figures refer to 1994 except in the case of collective bargaining coverage in Canada (1993), Finland (1995), France (1995), Italy (1993), Japan (1995), Norway (1993), Portugal (1993) and in the case of union density in Denmark (1993), Finland (1995), Germany (1993), Italy (1992), the Netherlands (1993), Portugal (1990), Sweden (1993) and Switzerland (1992).

Conceptually, external union power is a complex matter and thus difficult to assess. Often, union density, which is the proportion of eligible employees who become union members, has been considered as an initial but fundamental measure of union power. Union coverage, instead, is often in effect larger than the union density because statutory and other requirements extend the collectively-bargained wage to non-union employees. Union coverage is perhaps a more accurate measure of the extent to which unions affect wage levels than union density and for this reason maybe also more accurate measure of union power. In the empirical analysis, however, it turns out that neither the density nor the coverage rates alone can explain inflation, wage growth or unemployment. The reason is that union density nor union coverage as such does not tell anything about the actual monopoly power of the individual unions. The density and coverage can be high even in reasonable decentralised and un-cooperative wage bargaining systems, such as France..

We therefore propose an alternative measure of union power by *multiplying the degree of centralization and union density (MOPO)*. This measure of monopoly power of the unions takes into account the fact that in more centralized wage bargaining systems, a high density promotes monopoly power, while in highly decentralized systems high density does not secure monopoly power of the individual union.

### 2.5.6 The difference between union density and coverage rates

From table 2.5 we can see that the rates of union coverage and union density differ across countries by wide margins. This is evident from only a modest positive correlation ( $r = 0.32$ )<sup>24</sup> between the two rates. Several groups of countries can be identified. First, there is a group – Canada, Japan and United States – with below average coverage and unionization with little difference between them. Another group – Finland, Norway and Sweden, features very high unionization and coverage rates with a relatively modest difference between. The most interesting are perhaps the countries with considerable differences between the two. The gap is especially wide in France, but also significant in countries such as Austria, Germany, the Netherlands, Spain and Italy. The likelihood of

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<sup>24</sup>This correlation refers to year 1994.

the free rider problem is perhaps highest in those countries with large difference between these rates. In order to assess importance of large differences between these two rates, we constructed a new variable by subtracting union density from the union coverage (DICODE). The higher the value, higher the likelihood of free rider problems. In the empirical analysis, this variable partially explains the dispersion in wage growth and unemployment rates in OECD countries.

## 2.6 Recent institutional changes in wage bargaining

### 2.6.1 Decentralization

Many OECD countries have witnessed dramatic changes in the wage bargaining structure during late 1980s and early 1990s. From Table 2.4 we notice that the revision of the wage bargaining structure has implied either a greater emphasis on market forces and firm level bargaining or a greater emphasis on co-ordinated and centralised wage bargaining. Australia, Finland, New Zealand, Sweden and United Kingdom decentralised wage bargaining during the 1980s and 1990s. In New Zealand and in the United Kingdom extension procedures were rescinded in the early 1980s and New Zealand's Employment Contracts Act 1991 resulted in an extensive deregulation of labour law. As a result of this act, the system of collective bargaining that was conducted at multi-employer level basically collapsed. In the United Kingdom major individual company and plant agreements have taken over the pace-setting role of annual wage rounds. In both countries, coverage and unionization rates have decreased considerably, as well as a difference between them. In New Zealand, the number of workers covered by collective bargaining decreased by one half while the share of workers covered by multi-employer contracts fell even more, from 90% to 14% (Harbridge and Honeybone (1996)).

The Swedish bargaining system went through considerable decentralization at the beginning of 1990s. Sweden's highly centralised bargaining structure fell into crisis as it became less able to take into account the needs of the export sector and external competitiveness. This movement in Sweden was echoed in Finland. The central incomes policy agreements for 1992 and 1993 were an important step in promoting

wage bargaining at the company level. Aimed at restricting inflation and enhancing Finland's competitiveness, the agreement emphasized the necessity to develop a bargaining system that enabled parties to pay closer attention to the needs of companies and their employees at the workplace. Contrary to the U.K. and New Zealand, there have not been decline in unionization nor coverage rates, both of which have remained very high in Sweden and Finland. However, it is notable that a difference between coverage and unionization rate has been in decline since 1970s in both countries, reaching 2% in Sweden and 15% in Finland in 1994.

In Spain, as the government switched to tighter macroeconomic policies at the end of the 1980s, attempts that were made during the early phase of democracy to develop an economy-wide bargaining temporarily ceased. In 1992 a degree of economy-wide concentration was again temporarily restored, together with the new left-wing government's interest in macroeconomic restructuring. In 1994 the unions, however, became increasingly hostile to government proposals on labour market reform, leading to a general strike on January 1994. Although the unionization rate has been modest in Spain, the coverage rates reached almost 80% level in 1994. The difference between these two rates reached almost 60% level in 1994.

In Australia, the Accord struck in 1983 by the government and the Australian Council of Trade Unions centralised and co-ordinated the wage determination process. However, under the influence of the Accord, Australia's industrial tribunals subsequently initiated the process of decentralization, coupling wage settlements with increased enterprise-level bargaining. The unionization rate has been in steady decline since the 1970s reaching 32% in 1994, while the coverage rates has stayed at high level. (OECD (1997)).

From table 2.4 we notice that these developments are captured by the indices of centralization and co-operation aswell. Together with Australia, New Zealand, Sweden, and the U.K, also Denmark have both decentralised and moved towards more un-coordinated system. Italy, in turn, has centralised and moved towards more co-ordinated system, while Norway has moved towards more centralised wage bargaining system. At mid 1990s, purely decentralised wage bargaining systems can be found from U.S., Canada, New Zealand and the U.K. Somewhat paradoxically, the typical industry level bargaining systems are numerous and can be found from Belgium, Denmark, Finland, France, the Netherlands,



Portugal, Spain, Sweden and Switzerland. Austria, Germany and Norway represent the most centralised/co-ordinated systems, while Japan is an interesting exception with highly decentralized but co-ordinated system.

## 2.7 Reforms

Before turning into econometric analysis, it is interesting to study a link between labour market reforms and reforms in central banking. In table 2.6.A. we have grouped the countries according to the degree of legal independence and centralization of wage bargaining using the overall measure of legal independence of the central banks and a measure of the degree of centralization/coordination during the 1971–89.

Table 2.6.A. **Wage Bargaining and Central Bank Independence in 1971–1989**

		<b>Central Bank Independence</b>		
		Substantial	Medium	Moderate
W a g e b a r g i n g	Centralized	A, GER	-	FIN, SWE NOR
	Medium	-	U.K, AUS DEN, NL SPA, SWI	BEL, FRA ITA, NZ
	Decentralized	USA	CANADA	JAPAN

Table 2.6.A provides a fairly rough description but it is worth exploring. Polar cases are those of Austria and Germany, representing a combination of centralized/co-ordinated wage bargaining structure and an independent central bank. According to all theories, these countries should have had superior inflation and unemployment performance. Another, say, favorable institutional arrangement is that of USA with independent central bank combined with decentralized wage bargaining. If we believed in Calmfors-Driffill hypothesis and credibility arguments the USA should have low inflation at the given level of unemployment. At the other edge is Japan, which represents a decentralized, but co-ordinated wage bargaining system and a dependent central bank and Norway, which represents the centralized and fairly co-ordinated wage bargaining and a dependent central bank.

Table 2.6.B. **Wage Bargaining and Central Bank Independence in 1996**

		<b>Central Bank Independence</b>		
<b>W a g e b a r g i n g</b>		Substantial	Medium	Moderate
	Centralized	A, GER	-	NOR
	Medium	FIN*, FRA SPA*, SWE*	SWI, ITA NL, DEN BEL	-
	Decentralized	USA, U.K.* NZ*, CAN*	AUS	JAP

Notes: The central bank is considered independent if KICBI > 5, Medium, if 0.5 < KICBI < 3, moderately independent if KICBI < .3. If the country has chosen an explicit inflation targeting regime, it is considered as a substitute for the lack of legal independence. \* indicates inflation targeting countries. The degree of centralization/co-ordination of wage bargaining has been assessed as in table 2.4.

In table 2.6 B we assess the same situation after important changes in the labour markets and in the central bank laws in the late 1980s and 1990s. Clearly, towards the end of 1996 several countries witnessed drastic changes in both monetary regimes and wage bargaining structure. In particular, the U.K. and New Zealand have moved to an extreme of an independent central bank and decentralized wage bargaining. Also Finland, Spain and Sweden have changed the monetary policy framework centred with an explicit inflation target, while at the same time also the decentralization of wage bargaining has been visible. From the point of view of the history of corporatist institutions and economic policy making, based on economy-wide income policy, Sweden and Finland provide interesting examples of countries of substantial changes in the institutional framework of policy making. Canada, which adopted explicit inflation targeting in 1993 serves as an interesting comparison to Scandinavian countries due to the historically decentralised wage bargaining structure. In contrast, Germany, Austria, USA, Switzerland, Norway, Japan, Denmark and Netherlands have not changed their institutions considerably according to our measures. France, Canada, Italy and Belgium only changed monetary regime significantly. One country that significantly altered only the wage bargaining structure was Australia during 1980s and 1990s.<sup>25</sup>

<sup>25</sup>Notice, however, that we do not consider changes in the labour legislation.

## 2.8 A cross-section-time-series model

### 2.8.1 Setup of the model

In order to assess the statistical significance of these institutional structures and reforms, we estimated a cross-section-time-series model for inflation, nominal wage growth and unemployment rates. In contrast with other studies of the kind, we estimate a fully specified econometric model, extended with institutional variables for each price inflation, unemployment and wage inflation. We also account for endogeneity of the regressors and use specification tests to compare between different models. The endogeneity problem arises from the fact that inflation, wage growth and unemployment are jointly determined.

Primarily, our interest is to test whether, and how, inclusion of wage bargaining variables together with different measures of central bank independence discussed above helps to explain variation in macroeconomic performance in OECD countries during the period of 1972–1996. We are also interested in whether the Calmfors-Driffill hypothesis of hump-shaped relationship between wage growth and the degree of centralization on the one hand and unemployment and the degree of centralization on the other hand, gets support from the data. This section presents results from these estimations and discusses the results. A detailed discussion of the empirical methodology is left to the appendix A. In brief, we estimated the following equation for each price inflation, wage inflation and unemployment<sup>26</sup>.

$$\begin{aligned}y_{it} &= \delta y_{it-1} + x'_{it}\beta + Z'_{i(t)}\lambda + u_{it}, \quad i = 1, \dots, N, t = 1, \dots, T \quad (2.1) \\u_{it} &= \mu_i + \gamma_t + v_{it} \\v_{it} &= \rho v_{it-1} + \epsilon_{it}, \quad \epsilon_{it} \sim iid\end{aligned}$$

where

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<sup>26</sup>Portugal, Greece and Ireland were excluded from the estimated models due to the lack of data.

$Z_{i(t)}$ = institutional features of each country	$i$ denotes country
$u_{it}$ = error term	$T$ denotes time period
$\mu_i$ = random component (individual effects)	$y_{it}$ = inflation ( $\pi$ ), unemployment ( $U$ ) or nominal wage growth ( $W$ )
$\gamma_t$ = time effects common to all units	$y_{it-1}$ = one period lagged dependent variable
$v_{it}$ = possibly serially correlated component of errors	$x_{it}$ = time varying explanatory variables
	$\rho$ = autocorrelation coefficient

## 2.8.2 Estimation methodology and summary of the results

We first estimated the model for price inflation, nominal wage growth and unemployment without accounting for possible endogeneity of the regressors. Results from this basic model are presented in table 2.7, panel A. The endogeneity problem was then accounted by instrumental variable estimation. The lagged dependent variable was included into the model in order to remove serial correlation from the errors. Lagged dependent variable also captures the dynamic adjustment, since dependent variables inhibit a substantial degree of persistence in each equation. Serial correlation of the errors was then tested by a Lagrange Multiplier test ( $LM_\rho$ ). In the models for price inflation and wage growth lagged dependent variable and other explanatory economic variables were able to remove serial correlation from the errors. In the case of unemployment it was necessary to include also the lagged change in unemployment and other economic variables.

As discussed in the appendix A, inclusion of the lagged dependent variable among the regressors results in some collinearity problem between lagged dependent variable and institutional variables. In order to assess seriousness of this problem we also estimated the basic model without lagged dependent variable but with an autocorrelation correction for the errors, as suggested by Park (1967). In this case we assumed that autocorrelation coefficient ( $\rho$ ) for each country was the same. In the model where the lagged dependent variable was included into the model, autocorrelation coefficient ( $\rho$ ) was restricted to be zero. In general, the model specification remained the same, but significance of the institutional

effects was increased. Time effects were also included into the model, when appropriate. Time effects in the errors was then tested by a Lagrange Multiplier test ( $LM_\lambda$ ). The model misspecification was tested by testing whether individual effects should be included into errors. Again Lagrange Multiplier test was used ( $LM_\mu$ ). Finally it was assumed that errors were correlated and heteroskedastic across countries. The appropriateness of this assumption was tested by a Likelihood Ratio test, comparing the restricted and unrestricted model. The model specification was accepted when the model passed all these specification tests. Normality of the errors was also assessed using the test statistic. None of the models passed this test. This is not surprising, given the data at hand, since outliers are highly likely. Finally, although OLS estimation was used to estimate parameters of interest, robust standard errors were calculated following a method of Beck and Katz (1995).

In panel B of table 2.7 we relaxed an exogeneity assumption and estimated each model with the instrumental variables technique. Lagged values of explanatory economic variables were used as instruments. Institutional variables were not included into the instrument equation, in order to avoid orthogonality between instrumented regressors and institutional variables. Finally, we used growth rates of each country as an additional instrument.

After these two estimation rounds, we run instrumental variable regressions for each price inflation, wage growth and unemployment without the labour market variables. Our idea was to test whether exclusion of the labour market variables leads into misspecified model. Lagrange Multiplier test ( $LM_{\rho,\mu}$ ), which tested jointly whether errors contain a significant individual effects and whether the errors were serially correlated, tested this misspecification from the partial model. In addition, we used WALD test to test for joint significance of the labour market variables in the fully specified model. Finally, also the Calmfors-Driffill hypothesis was tested by WALD test from the fully specified model. Results from these estimations and tests are summarised in tables 2.8 and 2.9.

Table 2.7. Estimation Results from Complete Model

	OLS			IV		
	$\pi_{it}$	$W_{it}$	$U_{it}$	$\pi_{it}$	$W_{it}$	$U_{it}$
$\pi_{it}$		0.61 (0.070)			0.52 (0.151)	
$W_{it}$	0.36 (0.025)			0.30 (0.045)		
$\Delta U_{it}$	-0.15 (0.083)	-0.37 (0.124)	0.29 <sup>(a)</sup> (0.057)	-0.03 (0.199)	-0.83 (0.221)	.29 <sup>(a)</sup> (0.056)
$\pi_{it-1}$	0.45 (0.036)			0.44 (0.059)		
$W_{it-1}$		0.43 (0.057)			0.42 (0.107)	
$U_{it-1}$			0.91 (0.019)			0.92 (0.19)
$RW_{it}$			-0.11 (0.004)			-0.01 (0.007)
<i>POLI</i>	-1.28 (0.778)		-0.23 (0.112)	-2.05 (1.000)		-0.24 (0.106)
<i>PERI</i>		-1.59 (0.577)			-1.78 (0.647)	-0.08 (0.033)
<i>OBJE</i>		-0.69 (0.304)	0.06 (0.028)		-0.69 (0.363)	0.03 (0.025)
<i>EITAR</i>	-0.70 (0.475)	1.29 <sup>(b)</sup> (0.611)		-0.99 (0.505)	1.73 <sup>(b)</sup> (0.642)	0.016 (0.046)
<i>COOP</i>	-0.64 (0.149)	0.46 (0.194)	-0.03 (0.014)	-0.76 (0.190)	-0.24 (0.250)	-0.04 (0.016)
<i>CODE</i>		1.86 (0.657)	0.03 (0.040)		1.95 (0.762)	0.05 (0.047)
<i>MOPO</i>	0.36 (0.136)			0.48 (0.163)	0.29 (0.307)	
$C^2$		-0.16 (0.370)	-0.08 (0.029)		-0.07 (0.418)	-0.05 (0.028)
$N = 17$ (1972–1996)				$N = 17$ (1973–1996)		

Notes: OBJE measures an importance of price stability in the status of the central bank. POLI measures political independence of the central bank. PERI measures personnel independence of the central bank. COOP measures a degree of co-operation of wage bargaining (See table 2.2). Higher the index, higher the degree of co-operation. MOPO is constructed as  $MOPO = CENTRA \times DENSITY$  and captures a monopoly power of unions and effect of unions to aggregate wages. (See tables 2.2, 2.3). EITAR is dummy for countries that adopted inflation targeting (See table 2.1).  $C^2 = (2 - CENTRA)^2$  and captures the Calmfors-Driffill hypothesis of hump-shaped relationship between macroeconomic performance and a degree of centralization of wage bargaining. CODE=COVERAGE-DENSITY. RW is real wage growth. Values in brackets are panel-corrected standard errors (PCSE). See appendix A for details. a,b) lagged one period.

Table 2.8. **Estimation Results from Partial Model**

	$\pi_{it}$	$W_{it}$	$U_{it}$
$\pi_{it}$		0.49 (0.143)	
$W_{it}$	0.26 (0.045)		
$\Delta U_{it}$	0.19 (.183)	-0.80 (.222)	.32 (0.059)
$\pi_{it-1}$	0.50 (0.061)		
$W_{it-1}$		0.45 (0.103)	
$U_{it-1}$			0.92 (0.19)
$RW_{it}$			-0.01 (0.007)
$POLI$	-3.61 (1.080)		-0.07 (0.133)
$PERI$		-1.62 (0.588)	-0.07 (0.029)
$OBJE$		-0.38 (0.322)	0.05 (0.025)
$EITAR$	-.531 (.531)	1.59 (0.635)	0.02 (0.046)
$N = 17$ (1973 – 1996)			

Notes: Instrumental variable estimation with panel-corrected-standard-errors was used. See also table 2.7 above.

Table 2.9. **Hypothesis Testing**

	$\pi_{it}$	$W_{it}$	$U_{it}$
Misspecification test ( $LM_{\mu,\rho}$ )	2.62 (0.004)	1.09 (0.580)	0.06 (0.473)
WALD test for labour market variables	$\chi^2(2)$ 16.28 (0.000)	$\chi^2(3)$ 6.94 (0.078)	$\chi^2(4)$ 14.14 (0.006)
WALD test for C-D hypothesis	-	$\chi^2(1) = 0.04$ (0.833) $\chi^2(1) = 2.67^{(a)}$ (0.102)	$\chi^2(1)$ 2.80 (0.094)

Notes: a) This refers to the case where the variable DICODE, the difference between coverage and density rates, was excluded from the model.  $LM_{\mu,\rho}$  refers to joint test for serial correlation and individual effects in the errors. See appendix A for details.

## 2.9 Interpretations

### 2.9.1 Inflation

Our basic model for inflation showed that the importance of price stability objective in the status of the central bank (OBJE), which proxies the conservativeness bias of the central bank was not related to inflation significantly. The political independence of the central bank, however, appeared significant and negatively related to inflation. This seems to imply that conservativeness of the central bank per se does not secure moderate inflation. Granting political independence for the central bank seems to be decisive for moderate inflation rate.

Inflation seemed to be negatively related to the degree of co-operation and positively to the power of the unions. A higher degree of co-operation seems to moderate inflation, as expected, while a larger power of unions leads higher inflation. With regard to economic variables, we found out that wages were positively related to inflation, while the change in unemployment had negative effect on inflation.

After relaxing the exogeneity assumption the results changed somewhat. Most importantly, the inflation targeting dummy appeared negatively related to inflation at 5.2% significance level. This seems to imply that countries that adopted inflation targeting were able to achieve moderate inflation level faster than those following traditional approaches. Most likely this implies that an idea to substitute a lack of legal independence by the full instrument independence was successful. Moreover, power of the unions remained positive and significant together with the co-operation variable, which remained negatively and significantly related to inflation. All these results are, again, in line with theory, but they emphasise that moderate inflation rates are conditional not only on the legal independence of the central bank, but also on wage bargaining structure. The bottom line is, then, that it may not be sufficient to secure credibility of the central bank by granting legal independence for the central bank. Structural reforms in the wage bargaining practice may be necessary. Our results hint a need either to increase the co-operation in wage bargaining or decrease the power of the unions.

Formal Lagrange Multiplier test statistic shows that omitting labour market variables from the regression leads into a misspecified model. Moreover, WALD test statistic for omitting the labour market variables



rejects the hypothesis that labour market variables are insignificant. This can be seen from table 2.9.

### 2.9.2 Wage Growth

On the contrary to inflation model, and somewhat surprisingly, importance of the price objective in the status of the central bank had significant negative effect on nominal wage growth in the basic model. In addition, also the personnel independence of the central bank has contributed to moderate wage growth, while the political independence variable was not significant. However, in contrast to the results on inflation, inflation targeting dummy, when lagged one period, had a significant *positive effect on nominal wage growth*, while inflation targeting dummy without the lag was not significant.

The difference between coverage and density rates and power of the unions had marginally significant positive effect on wages, while the co-operation in wage bargaining had significant *positive effect on nominal wage growth*. This was somewhat unexpected since we found that inflation was negatively and significantly related to co-operation.

After relaxing exogeneity assumption, results changed somewhat. In general, significance of the institutional variables was reduced. In particular, the puzzling co-operation variable was no more significant while the personnel independence and importance of price objective status remained significant and negative. It is important to note that nominal wage growth seemed to be very closely related to the central bank independence variables. The fact that the OBJE variable, which proxies the conservativeness of the central bank, was significant and negative strongly supports the argument that wage bargaining institutions and their beliefs on policymakers preferences play an important role in successful economic policy. The fact that personnel independence of the central bank was significant and negative, gives support for the credibility arguments, that granting legal independence of the central banks increases the credibility of the policymakers and therefore, leads into moderate inflation expectations.

Formal Lagrange Multiplier test statistic shows that even if the labour market variables were omitted from the regression the model specification was accepted. However, WALD test statistic for omitting the labour market variables rejects the hypothesis that labour market variables are

insignificant marginally (see table 2.9). In addition, we tested formally the Calmfors-Driffill hypothesis according to which the relationship between centralization of wage bargaining and wage growth should be hump-shaped. This was tested again by WALD test. Omitting the variable (CENHUM), which captured this hump-shaped relationship, was not rejected. However, when the wage growth model was estimated without the variables DICODE (the difference between coverage and density rates), omitting  $C^2$  was rejected at 10% significance level. The reason for this is that DICODE and  $C^2$  variables are collinear.

### 2.9.3 Unemployment

We first experimented with the standardised unemployment rate, but experienced difficulties with the model specification. We decided to use the log of the standardised unemployment rates instead. Interestingly, we found that policy independence had significant negative effect on unemployment, while more emphasis on the objective of price stability in the central bank status had positive effect on unemployment. The latter result seems to be consistent with the finding that also the wage growth is negatively related to personnel independence, while the former results seem to be inconsistent with the result that the price stability objective had a negative effect on the wage growth. Nevertheless, the result that importance of price stability objective was positively related to unemployment gives some support for the argument that establishing weight conservative central banker is not like a free lunch.

The degree of co-operation in wage bargaining was negatively related to unemployment. The difference between coverage and density rates had significant positive effect on unemployment, when the model was estimated without the quadratic term CENHUM, capturing the Calmfors-Driffill hypothesis. When the model was estimated with both variables, only the quadratic term CENHUM remained significant. This is due to the fact that these two variables are highly correlated.

After relaxing exogeneity assumption, results again changed somewhat. In general, the significance of institutional variables was reduced. The importance of price objective in the status of the central bank did not remain significant. This is better in line with the result from wage growth equation, which showed that the price stability objective plays a role in moderating wage growth. Co-operation and personnel

independence variables, however, remained significant. The result that policy independence of the central bank leads moderate inflation and personnel independence leads into both moderate wage growth and unemployment rate gives a strong support for the arguments of Cottarelli and Giannini (1997). Namely, it seems that establishing arrangements which decreases the discretionary power of the government on central bank, but leaves necessary flexibility for the monetary policy is desirable. Moreover, because co-ordination variable both contributes moderate inflation rates and unemployment rates, it seems likely that in the co-ordinated wage bargaining systems, this co-ordination has improved the credence of the monetary policy as argued above.

Similarly with the wage growth equation, a formal Lagrange Multiplier test statistic shows that the model specification was accepted even without wage bargaining variables. WALD test statistic for omitting the labour market variables, in turn, rejects the hypothesis that labour market variables are insignificant. This can be seen again from table 2.9. Formal WALD test for Calmfors-Driffill hypothesis was marginally supportive. Omitting the variable ( $C^2$ ), which captured this hump-shaped relationship, was rejected at 9% significance level.

## 2.10 Concluding comments

First, it seems to matter which form of independence is emphasised when considering the status of the central banks. While higher political independence of the central bank seems to affect negatively on inflation, personnel independence contributes both lower unemployment rate and wage inflation. Increased emphasis of the price stability goal in the legal status of the central bank seems to generate some negative effects on unemployment, but this relationship was not robust in different specification of the model. Inflation targeting has proved fairly successful, generating moderate inflation rates, without costs in term of unemployment. With regard to labour markets, it seems to be that facilitating co-operation in wage bargaining is crucial and *ceteris paribus* yields moderate inflation and unemployment rates. On the contrary, a large difference between coverage and density rates leads to both higher nominal wage growth and higher unemployment rate. Calmfors-Driffill hypothesis gained some support from the data. However, due to the

high collinearity between the variable which captured this hump-shaped relationship and the variables which measures the difference between bargaining coverage and union density (DICODE), it is difficult to say, whether this effect was due to the quadratic term per se. Nevertheless, these results give evidence of the free-rider type of problems and strongly support a need either to reduce statutory arrangements that extends wage contracts to non-union members or a need to move away from the industry level bargaining systems, where the difference between coverage and density rates tend to be largest.

Surprising result was that adoption of inflation targeting had lagged positive effect on wage growth, but simultaneous negative effect on inflation. This may be due to the slow adjustment of inflation expectations at the beginning of new monetary regime. However, we did not find out that unemployment performance in the countries that adopted inflation targeting would have been significantly worse.

Our results suggest that the wage bargaining structure and the central bank independence are related to dispersion of macroeconomic performance in OECD countries in rather complicated fashion. It seems evident that empirical studies, which have studied these two issues separately have neglected an important interaction of wage bargaining parties and monetary authorities. This is evident from the fact that we find much more significant results with respect to wage bargaining structure than for instance OECD (1997), which abstain from the central bank independence discussion. Our formal tests for this significance most strongly suggested that estimated inflation model without labour market variables is misspecified. Moreover, a better understanding of this interaction requires to re-consider theoretical models, to which we turn in the next Chapters. In particular, our results doubt the theoretical findings of Bleaney (1996), that inflation is not dependent upon wage bargaining structure, while gives a clear support for the arguments and findings of Cubitt (1992), Iversen (1998) and Skott (1995).



# 3 Strategic Interaction of Fiscal and Monetary Policy in the Unionized Economy

## 3.1 Introduction

In the monetary policy games, discretionary policy making leads to an inflation bias that arises from monetary policy aimed at raising employment above its equilibrium level (Kydland and Prescott (1977), Calvo (1978), Barro and Gordon (1983a,b). Similarly, in explicit monopoly union government models, discretionary policymaking causes an excessive unemployment problem resulting from fiscal accommodation (Calmfors (1982), Calmfors and Horn (1985, 1986), Driffill (1985)). The proposals based on the conclusions of this literature, that the precommitment of policymakers and an appointment of an inflation adverse central banker can achieve moderate inflation at no real costs, has had major impact on the institutional design for the central banks in industrialized countries during the 1990s. The justification for these conclusions and the immense effects it has had on practical monetary policymaking in Europe, however, is found in a highly stylized and abstract macroeconomic model with little empirical support, as discussed in Chapter 1.

In this stylized generic model the rate of inflation is set by the government and the level of output (employment) is determined by an Expectations Augmented Phillips Curve, by the government's chosen rate of inflation and the expected inflation rate of the private sector.

The key element of the stylized model is the hypothesis that the output (employment) level targeted by the policymaker(s) is above the level that would be determined by the market without policy intervention. The

literature has basically put forward two arguments to justify this

- Labour market imperfections which force the equilibrium real wage to be above the level compatible with full employment (Canzoneri (1985), Rogoff (1985)).
- The existence of tax distortions that reduce the level of activity below its natural rate (Barro and Gordon (1983a)).

The first explanation takes a shortcut and treats labour market imperfections as exogenous which only provides the source of the time inconsistency problem, due to the conflict between private sector and the monetary policymaker. It implicitly assumes that labour market frictions affect the natural rate of employment. The exact nature of these labour market distortions is not well explained. The same applies to the second explanation. Namely, it is just hypothesized that the natural level of employment determined by the markets is low due to the existence of a distortionary tax. As noted by Herrendorf and Neuman (1997), the stylized model still lacks a convincing explanation of why the policymaker should have an ambitious employment target.

Nevertheless, one possibility to understand the private sector's behavior in the stylized model is to think of it as a rational expectation formation mechanism, where each agent employs the same forecasting rule with a same information. Another possibility is to think that there is a single monopoly union who cares about the real wage only and settles a one-year-wage-contract, setting the nominal wage consistently with the expected inflation during the contract period. Both of these assumption, when combined with an expectations augmented Phillips curve, leads to the paradigm where the private sector's actions in the game have no direct affect on inflation; the private sector's beliefs of future inflation only constraints the actions of the government. The assumption that the private sector minimizes only expectational errors obscures and trivializes the private sector's preferences about real economic outcomes, since it is difficult to see how they could rationally aim for anything other than correct beliefs. (Cubitt (1992)).

Cubitt (1992) argues that if the monopoly union cares both inflation and the level of output, the policy precommitment can be harmful and policymakers may benefit from being in the position of Stackelberg follower. Akhand (1992) has shown that monetary authority's precommitment is not enough to eliminate inflation bias; elimination of

co-ordination failure among the wage setters is needed as well. Skott (1995) extended the analysis of Cubitt (1992) and studied a case where the wage bargaining is partially decentralised. Skott (1995) finds out that decentralization of the wage bargaining tends to weaken the conclusion of Cubitt (1992). Also Bleaney (1996) have studied the model with the central bank and unions. He argues that the structure of the labour markets should not have any effect on the equilibrium level of inflation.

Finally, the stylized credibility model or the models of Cubitt (1992), Akhand (1992), Skott (1995) and Bleaney (1996) do not separate between the fiscal and the monetary authority. It is assumed that the fiscal and the monetary authority share the same preferences and policy is assumed to be set by a single authority. However, it is commonly agreed that the preferences of the fiscal policymaker and monetary policymaker do not need to coincide due to the different political constraints these policymakers are subject to. In many industrialized countries fiscal and monetary policies are set by independent authorities and the development of European Monetary Union leads to even more polarized situation where the European Central Bank will have a highly independent role in setting monetary policy, with national governments being responsible for the fiscal policy of their own country. Surprisingly, however, the time inconsistency problems of the fiscal and the monetary authorities have generally been studied separately, leaving the potentially important interactions between the fiscal and the monetary authorities unexplored (Jensen (1992a)).

Alesina and Tabellini (1987) and Jensen (1992a) study a model with two policymakers with conflicting views about importance of target levels of output, public expenditure and inflation. Both papers provide some additional support for the desirability of the precommitment of policy authorities when compared with a discretionary regime. Both of these models assume monopoly union, however. In addition, Jensen (1992a) have shown that a regime of co-ordinated monetary and fiscal policy may turn out to be counterproductive.

In the following Chapter we combine these new approaches to the traditional credibility models and analyze a policy game between the private sector, the fiscal and the monetary authorities. We model the private sector as a strategically acting labour force (monopolistic unions), where labour market distortions are due to the wage setters concern for relative wages. As already discussed in Chapter 1, for unionized economies the assumption of several (competing) unions seems much



more realistic than the assumption of a single actor (or single economy wide monopoly union). In Chapter 2 we have also shown empirically that the role of wage bargaining institutions has been crucial in the conduct of successful economic policy and still play an important role in wage determination in OECD countries. An appropriate specification of the utility function of the unions in the following model allows us to characterize some institutional features of the wage bargaining process actually observed in reality. We assume that the “representative” fiscal and monetary policymaker have the same targets, but they may attach different relative weights to these targets in their objective functions.

The rest of this Chapter is organized as follows. The second section introduces the model setup and the third section discusses the Nash equilibrium of the game. The fourth section analyzes the Stackelberg game where the unions act as leaders and analyzes some welfare implications of the model. Section 6 concludes.

## 3.2 The model

### 3.2.1 Supply equation

In this economy the log of output in period  $t$ ,  $y_t$ , is produced by using the only variable input labour, where the log of labour is denoted by  $l_t$ . For simplicity, and some loss in generality, we assume a constant-returns-to-scale technology, so that  $y_t = l_t$ . The government uses discretionary taxes,  $\tau_t$ , collected from the competitive firm’s total revenues, to finance part of its public expenditure. The log of the economy wide nominal wage rate,  $w_t$ , is set by the monopolistic unions in a labour contract drawn up prior to the realization of the price level and prior to the realization of the tax rate  $\tau_t$ . Upon observing  $p_t$  and  $\tau_t$ , competitive firms choose their profit maximizing quantity of labour along their marginal productivity curve at the contracted wage rate,  $w_t$ . That is, output is determined by the Fisher (1977)/Taylor (1980) aggregate supply function, extended to account for the effect of distortionary taxes as follows

$$y_t = \bar{y} + p_t - w_t - \tau_t \quad (3.1)$$

where  $\bar{y}$  is log of the constant natural rate of output and  $w_t = \frac{1}{N} \sum_{i=1}^N w_{it}$  is log of the economy wide wage level. Without loss of generality we set the natural rate equal to 1.

### 3.2.2 Wage setters

Following Blanchard (1986) and Akhand (1992), we assume that there are  $N$  wage setters. The wage setters supply a different type of labour, indexed by  $i = 1, \dots, N$ . All types of labour are imperfect substitutes. The wage setters can be understood as utility maximizing unions (monopolistic households) who provide labour for the competitive industry, facing the labour demand function given below as (3.3). We assume the following convenient separable utility function for the each union

$$u_{it} = l_{it} + (w_{it} - p_t) l_{it} \quad (3.2)$$

$$l_{it} = \frac{y_t}{N} - \gamma_i (w_{it} - w_t) \quad (3.3)$$

where  $l_{it}$  is employment share of union  $i$ . Each union cares about its employment share  $l_{it}$  as well as its real wage  $(w_{it} - p_t)$ . At the given level of employment share, each union wants the real wage be as high as possible. Combining these, we obtain

$$u_{it} = [1 + (w_{it} - p_t)] \left[ \frac{y_t}{N} - \gamma_i (w_{it} - w_t) \right] \quad (3.4)$$

$\gamma_i > 0$  is a measure of a degree of monopoly power of the wage setter  $i$  (or the elasticity of the demand for the labour of type  $i$  with respect to its relative wage).  $N$  and  $\gamma_i$  capture an essential institutional structure of the labour markets.  $N$  should be interpreted as a proxy for the centralization of wage bargaining. When the number of unions increases, each union's relative significance in the aggregate level of wages decreases and at the same time, each union becomes less concerned with aggregate labour demand. Practically, this means that each union is less able to exploit its monopoly power, while at the same time, each union becomes less concerned with the effect of its wage decision on the aggregate wage. Which effect is stronger, depends on the size of the  $\gamma_i$ , i.e. the elasticity of demand for labour of type  $i$  with respect to its relative wage and number

of unions.<sup>27</sup>

The dependence of  $u_{it}$  on  $(w_{it} - p_t)$  reflects conflicting employment goals of the monetary authority and the wage setters and is one source of the time inconsistency problem of the policymakers. Usually, the source of the time inconsistency problem arises from the fact that a log of the natural rate ( $\bar{y}$ ) sought by the policymakers is assumed to be higher than that sought by the private sector or the one which would prevail in a decentralised economy. Here we do not need to make this ad hoc assumption. The time inconsistency problem arises from the dependence of  $u_{it}$  on  $(w_{it} - w_t)$  which produces a direct source of conflict among the wage setters. More precisely, the utility function implies that when there is a moderate degree of wage competition, given  $p_t, w_{it}, \tau_t$ , the wage setter  $j \neq i$  can raise its pay-off by setting the nominal wage rate slightly above the economy wide wage rate. This, however, pushes the relative wage of the wage setter  $i$  below its desired rate, because of a decline in its employment share. To preserve its own optimal relative wage rate, the wage setter  $i$  sets the nominal wage high enough so that others resist a temptation to raise their relative wages. This tension in the wage setting process describes a *Keynesian type of coordination failure* among the wage setters and is the principal cause of the time inconsistency problem in the model.

### 3.2.3 Policy makers

We assume separate authorities for fiscal and monetary policy in this economy that are <sup>28</sup> linked through a simple instantaneous budget constraint. The fiscal authority (government) controls the tax rate, whereas the monetary authority (central bank) controls money growth and thereby inflation. The one period loss functions of the government and the central bank are assumed to be as follows

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<sup>27</sup>Because our interest is primarily in the interaction between the wage setters and the policymakers we ignore the wage bargaining game between firms and the unions. This is an obvious limitation of the model, because in some countries (notably in Japan and Switzerland) the issue of co-ordination within employer organizations seem to have an important role in holding down wage increases (Soskice (1990)).

<sup>28</sup>Alesina and Tabellini (1987), Jensen (1992a) and Beetsma and Bovenberg (1996) have used the similar kind of formulation of loss functions.

$$V_t^{GOV} = -\delta_1(y_t - \bar{y})^2 - \delta_2(g_t - \bar{g})^2 - \pi_t^2, \delta_i \geq 0 \quad (3.5)$$

$$V_t^{CB} = -\beta_1(y_t - \bar{y})^2 - \beta_2(g_t - \bar{g})^2 - \pi_t^2, \beta_i \geq 0, i = 1, 2 \quad (3.6)$$

where *GOV* refers to the government and *CB* to the central bank. Both policymakers dislike deviations in the log of output  $y_t$  from the log of the natural rate ( $\bar{y}$ ). We assume, as usual in this literature, that the natural level of output would be generated by competitive labour markets with no tax distortions, no labour market distortions and no price surprises as in (3.1). Furthermore, policy authorities dislike deviations in the public spending ratio ( $g_t$ ) from some exogenous “socially desirable” target value ( $\bar{g}$ ), as well as price instability ( $\pi_t$ ). The hypothesis that  $\bar{g}$  is positive is crucial for the results that follow. In particular, when  $\bar{g}$  is positive, the policymakers tolerate some inflation and some tax distortions in exchange for a positive amount of public expenditure.

Although the goals of the government and central bank are the same, policymakers may attach different relative weights to employment and public expenditure. This is due to the fact that the central bank does not face the same political constraints as the government. We postulate that setting  $\beta_i < \delta_i$  implies the same as appointing a weight conservative central bank. The special case where  $\delta_i = \beta_i$  implies that the government and the central bank shares the same preferences. We use this specification to characterize economies with a discretionary central bank.<sup>29</sup>

### 3.2.4 Budget constraint

Public expenditure ( $g_t$ ) is financed solely from tax revenues (collected from the firms) and money creation (seignorage). Public expenditure is therefore residually determined by taxes and seignorage and approximated<sup>30</sup> by

$$g_t \equiv \tau_t + \pi_t \quad (3.7)$$

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<sup>29</sup>The model, however, remains partial as long as we do not make any formal arguments on how these weights are actually formed. The welfare implications of this model are questionable, because we do not model explicitly the preferences of the government. An interesting extension would be to include, say, a voting procedure from which the preferences of the government could be derived.

<sup>30</sup>For derivation see for instance Canzoneri (1985) and Alesina and Tabellini (1987).

where  $g_t$  denotes the ratio of public expenditure to nominal output and  $\pi_t$  is the rate of inflation. Without loss of generality in this one-shot-game, we normalize so that  $p_{t-1} = 0$ , hence the price level and inflation are effectively the same.  $\tau_t$  is the tax rate levied on firms' total revenues.<sup>31</sup> Taxes have no demand effects, as any tax induced change in public expenditure is offset by an equivalent change in private expenditure. This implies that we ignore multiplier effects of the balanced budget. Consequently, taxes only affect the economy through their distortionary effect on the firm's labour demand decision. An obvious caveat implied by the model's specification is that inflation and thus the price level is perfectly controlled by the monetary authority. In a more realistic setup, wage bargaining would have direct effects on prices, due to the interaction between the wage setters and profit maximizing firms. Another limitation of the model is that it is inherently a partial equilibrium model. Government expenditure is not returned to the economy.

## 3.3 Discretion

### 3.3.1 Wage setters

We now compute the time consistent (discretionary) Nash equilibrium of the game where neither the authorities nor the wage setters can precommit.<sup>32</sup> In the literature, the discretionary equilibrium has basically been calculated in two different ways. Barro and Gordon (1983a,b) considered discretionary policy as a Nash game between the central bank and the private agents, while Alesina and Tabellini (1987), Basar and

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<sup>31</sup>Theoretically one should expect the equivalence of labour taxation (divided into income taxes levied on employees and payroll taxes levied on firms) i.e. it should not matter for wages and employment which side the tax is levied on. Rasmussen (1994), however, has shown that under certain circumstances the structure of labour taxation has consequences on wages and employment. We will not explore this question in this Chapter.

<sup>32</sup>If this static game, where all players act like Nash players, taking the current actions of everybody else as given, were repeated a finite number of times the only subgame perfect (and hence time-consistent) Nash equilibrium of the repeated game would coincide with the unique Nash equilibrium of the one-shot game. If the game were infinitely repeated, the one-shot Nash equilibrium would still be an equilibrium of the game. In general, however, there could be other equilibrium sustainable by means of reputational forces.

Salmon (1990), Akhand (1992) and Jensen (1992a,b) considered the discretionary case as a Stackelberg leadership game between the policy authority and a monopolistic trade union(s). In these models, the union(s) act as a leader and the policy authority has to take the wage decision of the union(s) as given. When the fiscal and monetary policy makers are separated, as in the models of Alesina and Tabellini (1987), Jensen (1992a), Debelle and Fischer (1994), Beetsma and Bovenberg (1996), the issue is more complicated, but this does allow a richer variety of institutional issues to be considered. I analyze first the standard time consistent Nash equilibrium and discuss the Stackelberg alternatives in the next section.

We start with the wage setters. The reaction function of the wage setter  $i$ , given  $w_{jt}$ ,  $j \neq i$ ,  $p_t$ ,  $\tau_t$ , can be obtained by maximizing (3.4) s.t. (3.3). That is,

$$\max_{w_{it}} u_{it} = [1 + (w_{it} - p_t)] \left[ \frac{y_t}{N} - \gamma_i (w_{it} - \frac{1}{N} \sum_{j=1}^N w_{jt}) \right] \quad (3.8)$$

s.t.

$$y_t = 1 + (p_t - \frac{1}{N} \sum_{j=1}^N w_{jt} - \tau_t) \quad (3.9)$$

After imposing symmetry so that  $\gamma_i = \gamma_j = \gamma$ , the solution to this problem yields the following optimal wage rule

$$w_{it}^d = p_t + \sigma_h - \varphi_h \tau_t \quad (3.10)$$

where

$$\sigma_h = \frac{(N-1)(1-N\gamma)}{1+N(\gamma(N-1)+1)} \quad (3.11)$$

$$\varphi_h = \frac{N}{1+N(\gamma(N-1)+1)} \quad (3.12)$$

Because of symmetry,  $w_{it}^d$  also represents an aggregate wage rule and thus constitutes the aggregate outcome of the set of individual utility maximizing strategies, given the actions of the other wage setters and the policy authorities.

The wage competition bias ( $\sigma_h$ ) is positive for all  $\gamma < \frac{1}{N}$  and disappears when  $N = 1$  or when  $\gamma = \frac{1}{N}$ . It is also clear that  $\sigma_h \in (0, 1)$  for

all  $N \in (1, \frac{1}{\gamma})$  (i.e. when each wage setter has some monopoly power).<sup>33</sup> Main features of the terms  $\sigma_h$  and  $\varphi_h$  are summarized in the following propositions. For the sake of clarity, subscripts have been omitted.

**Proposition 1**  $\frac{\partial \sigma}{\partial N} \geq 0, \frac{\partial \varphi}{\partial N} \geq 0$ , for all  $1 \geq N^2 \gamma$ . *Otherwise negative.*

**Proposition 2**  $\frac{\partial \sigma}{\partial \gamma} \leq 0, \frac{\partial \varphi}{\partial \gamma} \leq 0, N \geq 1$ .

**Proposition 3**  $\frac{\partial(w-p)}{\partial N} \geq 0$ , for all  $1 \geq N^2 \gamma$ . *Otherwise negative.*

**Proposition 4**  $\frac{\partial(w-p)}{\partial \gamma} \leq 0$ , for all  $N \geq 1$ .

The wage competition bias depends crucially on the number of unions and hence the monopoly power of each. If we interpret the number of unions ( $N$ ) in the wage bargaining process as a proxy for the degree of centralization in wage bargaining, it can be noticed that the bias is hump-shaped as suggested in Calmfors and Driffill (1988). The wage bargaining systems that are somewhere between the centralised and decentralised systems are characterized as having the highest real wage bias. The parameter  $\gamma$  embodies the degree to which wage setters are affected by the wage decisions of the others. At sufficiently high level of competition ( $\gamma > \frac{1}{N^2}$ ) an increase in the number of unions leads to a lower nominal wage demand.

While  $\sigma_h$  characterizes a coordination failure in the labour markets, the term  $\varphi_h$  describes the optimal reaction of the wage setters to taxes. The pattern of  $\varphi_h$  is very similar to  $\sigma_h$ . Moreover,  $\varphi_h \in (0, 1)$  for all  $N \in (1, \frac{1}{\gamma})$ . The crucial difference with the simple Barro-Gordon (1983a,b) type of model is that the optimal reaction of the wage setters to the government's policies is dependent on the interaction of the wage setters and thus institutional features of wage bargaining.

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<sup>33</sup>It can easily be shown that within a parameter range  $N \in (1, \frac{1}{\gamma})$ , the game among wage setters exhibits negative spillovers and strategic substitutability. Cooper and John (1988) show that the strategic complementarity or substitutability and spillover effects are central to the Keynesian type of models and are necessary for the multiplier effects, which may induce multiplicity of equilibrium. It can be shown that the game among wage setters does not have multiple equilibrium, however.

### 3.3.2 Policymakers

The reaction functions for the government and the central bank can be easily obtained from the first order conditions (taxes are set by the government and inflation by the central bank). It follows that

$$(g_t^d - \bar{g}) = \frac{\delta_1}{\delta_2}(y_t - 1) \quad (3.13)$$

$$\pi_t^d = -\theta(y_t - 1) \quad (3.14)$$

where  $\theta = \frac{(\beta_1 \delta_2 + \beta_2 \delta_1)}{\delta_2}$ . Equilibrium taxes can be found from the budget identity, (3.13) and (3.14). What follows is then

$$\tau_t^d = \phi(y_t - 1) + \bar{g} \quad (3.15)$$

where  $\phi = \frac{(1 + \beta_2)\delta_1}{\delta_2} + \beta_1$ .

According to (3.15), taxes are an increasing function of the deviation of the log of output from the log of the natural level. In an equilibrium where output is below the target level ( $y_t < 1$ ), the government has greater incentive to set a lower tax rate lower the more the central bank is concerned with output, i.e.  $\frac{\partial \tau_t^d}{\partial \beta_1} > 0$ . An interesting policy issue arises, because as can be seen from (3.15) the government's incentives to accommodate is dependent on the relative importance of output compared to public expenditure ( $\frac{\delta_1}{\delta_2}$ ) when the weight it attaches to inflation is unity. The central bank's incentives to finance part of the public expenditure by seignorage also depends on the relative weight the government attaches to output. Finally, as already illustrated, the wage setters' reaction to taxes is dependent on the institutional structure of the labour markets.

### 3.3.3 Nash equilibrium

Using (3.15), (3.14) and (3.10), we find that output becomes

$$y_t^d = 1 - \frac{\sigma_h + (1 - \varphi_h)\bar{g}}{1 + (1 - \varphi_h)\phi} \quad (3.16)$$



where  $\sigma_h$  and  $\varphi_h$  are as in (3.11) and (3.12) and  $\phi = \frac{(1+\beta_2)\delta_1}{\delta_2} + \beta_1$ .

Substituting (3.16) into (3.14) we obtain the equilibrium inflation rate (price level)

$$\pi_t^d = \theta \frac{\sigma_h + (1-\varphi)\bar{g}}{1 + (1-\varphi)\phi} \geq 0 \quad (3.17)$$

where  $\theta = \frac{\beta_1\delta_2 + \beta_2\delta_1}{\delta_2}$ ,  $\phi = \frac{(1+\beta_2)\delta_1}{\delta_2} + \beta_1$ . Finally, the residually determined public expenditure will be

$$g_t^d = \bar{g} - \frac{\delta_1}{\delta_2} \frac{\sigma_h + (1-\varphi)\bar{g}}{1 + (1-\varphi)\phi}. \quad (3.18)$$

Clearly, inflation is excessive and output below the target level in this economy. The moderate level of output provides an incentive for the fiscal authority to cut taxes in order to accommodate the problem, while excessive inflation weakens the fiscal authority's incentive to finance expenditure through taxation. Clearly, *the more the monetary authority is concerned with output, the higher is its incentive to create surprise inflation in order to boost output.* An essential feature of the equilibrium is that output, inflation and public expenditure is not only dependent on the choice of the weights of the policymakers, but also on the wage competition bias i.e. the coordination failure in wage setting. I summarize the features of the Nash equilibrium in the following propositions (superscripts have been omitted):

**Proposition 5** *Given  $\gamma, \beta_1, \beta_2, \delta_1, \delta_2, \bar{g}$ , the log of output deviates most from the log of its target level and inflation is highest in the Nash equilibrium when  $N = \sqrt{\frac{1}{\gamma}}$ . In terms of output and inflation, the situation is best, when  $N = 1$  or when  $N = \frac{1}{\gamma}$ .*

**Proposition 6**  $\frac{\partial(y_t-1)}{\partial\beta_1} \geq 0$ ,  $\frac{\partial(y_t-1)}{\partial\beta_2} \geq 0$ ,  $\frac{\partial(y_t-1)}{\partial\delta_1} \geq 0$ ,  $\frac{\partial(y_t-1)}{\partial\delta_2} \leq 0$ .

**Proposition 7**  $\frac{\partial\pi_t}{\partial\beta_1} \geq 0$ ,  $\frac{\partial\pi_t}{\partial\beta_2} \geq 0$ .

**Proposition 8**  $\frac{\partial\pi_t}{\partial\delta_1} \geq 0$ ,  $\frac{\partial\pi_t}{\partial\delta_2} \leq 0$ , iff  $\frac{\beta_2}{\beta_1} \geq (1-\varphi)$ . Otherwise the opposite.

**Proof.** Taking the derivative  $\frac{\partial\pi_t}{\partial\delta_1}$  yields

$$\frac{\partial\pi_t}{\partial\delta_1} = \frac{\delta_2 (\sigma_h + g(1-\varphi))(\beta_2 + \beta_1(\varphi - 1))}{(-\delta_2(1 + \beta_1) - (\beta_2 + 1)\delta_1 + \varphi(\delta_1(1 + \beta_2) + \beta_1\delta_2))^2}.$$

Noticing that the denominator is always positive we find that

$$\begin{aligned}\frac{\partial \pi_t}{\partial \delta_1} &\geq 0 \\ &\Leftrightarrow \\ \frac{\beta_2}{\beta_1} &\geq (1 - \varphi)\end{aligned}$$

because  $\varphi \in (0, 1)$ ,  $\sigma \in (0, 1)$ ,  $\delta_2 \geq 0$  and therefore  $\delta_2 (\sigma_h + g(1 - \varphi)) \geq 0$ . Similarly with  $\frac{\partial \pi_t}{\partial \delta_2}$

**Proposition 9**  $\frac{\partial(g_t - \bar{g})}{\partial \beta_1} \geq 0$ ,  $\frac{\partial(g_t - \bar{g})}{\partial \beta_2} \geq 0$ ,  $\frac{\partial(g_t - \bar{g})}{\partial \delta_1} \leq 0$ ,  $\frac{\partial(g_t - \bar{g})}{\partial \delta_2} \geq 0$ .

The first proposition highlights the symmetric nature of the Nash equilibrium when compared with different levels of centralization in the wage bargaining. Namely, either in the case of the monopoly union ( $N = 1$ ) or in the case of perfectly competitive labor markets  $N = \frac{1}{\gamma}$ , the economy can reach the lowest inflation rates and output deviates least from the target level.<sup>34</sup> On the contrary, the situation seems to be worst, when the labor market system is between these extremes (hybrid system), as pointed out by Calmfors and Driffill (1988).

This clearly has some implications for labor market reforms. Namely, in order to reduce distortions from the labor markets to the aggregate economy through an institutional reform, the underlying (micro) processes which lead to these distortions must be well understood. Otherwise, an institutional reform which, for instance, moves from a centralized wage bargaining to a slightly more decentralized wage bargaining system may make the situation worse. As suggested by Calmfors and Driffill (1988), the main point is that when thinking about institutional reform of the labor markets, one should ensure that institutional reform does not only go to half-way.

Our empirical results in Chapter 2 provided some evidence on Calmfors-Driffill hypothesis, and showed that wage growth and unemployment tend to be higher in countries with industry level bargaining systems when compared with decentralized or decentralized systems. However, notice that in this Nash equilibrium wages depends only upon labor market characteristics, while our empirical analysis

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<sup>34</sup>We may consider the situation where  $N = \frac{1}{\gamma}$  as the competitive labor markets, since this implies that the individual union's attempt to raise its relative wage is offset by an equivalent increase in the aggregate wage level. In such a case  $\sigma = 0$ .

clearly showed that wage growth dependent upon degree of legal independence of the central bank as well.

Proposition (8) states that the sign of  $\frac{\partial \pi^d}{\partial \delta_i}$  is ambiguous. The sign depends upon the central banks preferences and the structure of the labor markets. In particular, when  $\frac{\beta_2}{\beta_1} \geq (1 - \varphi_h)$ , the more the government attaches weight to the output target, the higher inflation will be. The likelihood that this happens is greater the more the central bank attaches weight to the public expenditure target relative to the output target and the larger the distortions in the labor markets. Whilst it is conventionally argued that the government's accommodation in this type of models has no desirable results, these results show that desirability of accommodation is conditional on both preferences of the policymakers and the structure of the labor markets.

As already pointed out, in this discretionary equilibrium wages seem not to be conditional on the parameters in the policymakers utility function. This is due to the fact that in the discretionary equilibrium wage setters take the policy as given. Given our empirical findings, this seems implausible. We therefore turn to analyze a more interesting case of the wage setters' leadership game.

## 3.4 Wage setters' leadership

### 3.4.1 Some institutional considerations

When the private sector forms rational expectations of government policies, and it is assumed that the private sector minimizes expectational errors, the situation is best described by a Stackelberg leadership game where the government acts as a dominant player and the private sector acts as a follower (see for instance Petit (1990) in the context of dynamic games). Accordingly, in the simple Barro-Gordon type of model the private sector (representative agent) forms rational expectations of, say, inflation set by the government, and the government can take these expectations as given. One possibility of understanding the private sector's behavior in the stylized model is to think of it as a rational expectations formation mechanism, where each small enough agent employs the same forecasting rule and uses exactly the same information. Another possibility is to think that there exists a single monopoly union which

cares about the real wage only and agrees a one-year wage contract, setting the nominal wage in accordance with the rational expectations of inflation during the contract period.

In unionized economies, where at least partially centralized labor unions play a role in wage determination, such institutions may have the possibility to precommit and clearly have preferences with regard to economic outcomes, other than real wages only. In such a setting wage setters can behave strategically against the policymakers, while the government's policy actions can change the interaction between the wage setters, hence affecting indirectly the private sector equilibrium. The existence of binding wage contracts<sup>35</sup> imply that the policymakers may no longer have the dominant role because the wage setters have precommitted themselves to a negotiated wage<sup>36</sup> conditional on the policymakers' announcement regarding future policy. In unionized economies, where centralized wage setting play a role nominal wages are typically fixed by at least a one-year wage contract. Our empirical results from Chapter 2 also provided support for this kind of behavior. We assume, therefore, that the wage setters commit themselves to one-period contracts conditional on the policy authorities' announcement about future policy.<sup>37</sup> We retain the assumption that wage setters act simultaneously among themselves.<sup>38</sup>

The strategic interaction between the central bank and the government is another important question. The most realistic assumption, in the context of non-cooperative games, is that the government and the central bank play a Nash game or that the government acts as a leader. The

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<sup>35</sup>There is rather extensive literature which considers wage contracts and staggered wage setting. Seminal works are Taylor (1979, 1980) and Calvo (1983). For more recent works, see for instance Lau (1996).

<sup>36</sup>Long-term contracts are coupled with centralized wage setting notably in Scandinavian countries and Japan.

<sup>37</sup>Gylfason and Lindbeck (1986) argue that it is somewhat hazardous to apply simple scheme of alternative strategies to a real world situation. Labor market institutions in different countries differ to great extent and therefore, the leadership of the unions may not be plausible in some countries (Japan, Switzerland, and Austria), while in a other countries, notably in Sweden and Finland, the leadership of the unions could be easily accepted. In some countries (e.g. the U.K), the 'warfare' between the unions and the government would probably illustrate the situation best.

<sup>38</sup>Driffill (1987) has emphasized that the governments of industrial countries have used monetary and fiscal stabilization triggered by the actual unemployment level, with no reference to the real wage, with the aim of achieving target unemployment. Also, while the unemployment rate can be continuously and accurately monitored, real wages are more difficult to measure.

leadership of the government could be based on the fact that the government commits itself through the political budgetary process while the central bank is more free to adjust monetary policy. This would induce another interesting precommitment problem for the government. In this context, however, we assume that the central bank and the government move simultaneously.

### 3.4.2 Stackelberg equilibrium

The Stackelberg game will be solved backwards, starting from the policymakers. Since the authorities move simultaneously, their reaction functions are as in (3.13) and (3.14). We assume that wage-setters maximize their utility conditional on future policies by first solving the policymakers optimization problem. That is, we substitute policymakers' reaction functions into the unions' maximization problem. The maximization problem is as follows

$$\underset{w_{it}}{\text{Max}} u_{it} = [1 + (w_{it} - p_t^d)] \left[ \frac{y_t}{N} - \gamma_i(w_{it} - \frac{1}{N} \sum_{j=1}^N w_{jt}) \right] \quad (3.19)$$

s.t.

$$y_t = 1 + (p_t^d - \frac{1}{N} \sum_{j=1}^N w_{jt} - \tau_t^d)$$

$$p_t^d = \left( \frac{\theta \bar{g}}{1 + \theta + \phi} + \frac{\theta \left( \sum_{j=1}^N w_{jt} \right)}{(1 + \theta + \phi)N} \right)$$

$$\tau_t^d = \frac{(1 + \theta)\bar{g}}{1 + \theta + \phi} - \frac{\phi \sum_{j=1}^N w_{jt}}{(1 + \theta + \phi)N}$$

where  $\theta$  and  $\phi$  are as before.<sup>39</sup>

Solution of the first order conditions yields the following optimal wage rule

$$w_t^{pc} = p_t^d + \sigma_{pc} - \varphi_{pc} \tau_t^d \quad (3.20)$$

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<sup>39</sup> $p_t^{TCN}$  and  $\tau_t^{TCN}$  have been obtained as a solution of the simultaneous equation system  $p_t^{TCN} = -\theta(p_t^{TCN} - \frac{1}{N} \sum_{j=1}^N w_{jt} - \tau_t^{TCN})$ .  $\tau_t^{TCN} = \phi(p_t^{TCN} - \frac{1}{N} \sum_{j=1}^N w_{jt} - \tau_t^{TCN}) + \bar{g}$ .

where

$$\sigma_{pc} = \frac{(N-1)(1-N\gamma) + \frac{\phi}{1+\theta+\phi}}{N(1+(N-1)\gamma) + \frac{1-\theta}{1+\theta+\phi}} \quad (3.21)$$

$$\varphi_{pc} = \frac{N - \frac{\theta}{1+\theta+\phi}}{N(1+(N-1)\gamma) + \frac{1-\theta}{1+\theta+\phi}} \quad (3.22)$$

and where  $\theta = \frac{\beta_1\delta_2 + \beta_2\delta_1}{\delta_2}$ ,  $\phi = \frac{(1+\beta_2)\delta_1}{\delta_2} + \beta_1$ . Compared with the Nash game (discretion), the nominal wage rule depends, not only on the labor market structure, but also upon the preferences of the policymakers. Given our empirical findings, this seems more plausible and is due to the union(s) leadership role and their ability to exploit the reaction function of the policymakers. Equilibrium can be formed by solving the following system of equations.

$$\begin{aligned} p_t^d &= \left( \frac{\theta\bar{g}}{1+\theta+\phi} + \frac{\theta}{(1+\theta+\phi)} w_t^{pc} \right) \\ \tau_t^d &= \frac{(1+\theta)\bar{g}}{1+\theta+\phi} - \frac{\phi}{(1+\theta+\phi)} w_t^{pc} \\ w_t^{pc} &= p_t^d + \sigma_{pc} - \varphi_{pc}\tau_t^d \end{aligned}$$

yielding the solution

$$\tau_t^{pc} = \frac{\bar{g} - \phi\sigma_{pc}}{1 + (1 - \varphi_{pc})\phi} \quad (3.23)$$

$$\pi_t^{pc} \equiv p_t^s = \theta \frac{(1 - \varphi_{pc})\bar{g} + \sigma_{pc}}{1 + (1 - \varphi_{pc})\phi} \quad (3.24)$$

$$w_t^{pc} = \frac{\sigma_{pc}(1 + \theta + \phi) - (\varphi_{pc} + (\varphi_{pc} - 1)\theta)\bar{g}}{1 + (1 - \varphi_{pc})\phi} \quad (3.25)$$

Substituting these values into the aggregate output equation (3.1) we obtain the equilibrium output

$$y_t^{pc} = 1 - \frac{(1 - \varphi_{pc})\bar{g} + \sigma_{pc}}{1 + (1 - \varphi_{pc})\phi} \quad (3.26)$$

It follows that public expenditure in the equilibrium is

$$g_t^{pc} = \bar{g} - \frac{\delta_1 \sigma_{pc} + (1 - \varphi_{pc})\bar{g}}{\delta_2 + 1 + (1 - \varphi_{pc})\phi}. \quad (3.27)$$

We now take a closer look at the Stackelberg equilibrium and in particular, demonstrate that the conventional inflation bias results are not robust to different institutional settings of the economy.

## 3.5 Some results from different institutional settings of the economy

### 3.5.1 A weight conservative central bank

Our interest is now primarily on that how the labor market structure influences outcomes under different incentives of the policymakers. First, we analyze the case where monetary authority has no incentives to accommodate. That is, we set  $\beta_1 = \beta_2 = 0$ . In order to highlight how the degree of centralization of wage bargaining influences equilibrium, we analyze 3 different wage bargaining systems. First, we set  $N = 1$ , which implies that there is monopoly union in the economy. Second, we choose  $\gamma = \frac{1}{N}$ , which implies “competitive labor markets”. Third, we choose  $N = \sqrt{\frac{1}{\gamma}}$ , which refers to the “hybrid wage bargaining system”. Strategic assumptions remain the same for each choice of N, however. We analyze each regime in turn, starting from the monopoly union case.

Setting  $N = 1$  and  $\beta_i = 0$ , we find first that

$$\sigma_{pc} = \frac{\delta_1}{2\delta_2 + \delta_1} \quad (3.28)$$

$$\varphi_{pc} = \frac{\delta_2 + \delta_1}{2\delta_2 + \delta_1}. \quad (3.29)$$

Substituting these into (3.26) we obtain equilibrium output of

$$y_t^{pc} = 1 - \frac{\delta_2 \bar{g} + \delta_1}{2(\delta_2 + \delta_1)}. \quad (3.30)$$

Since the central bank has no incentives to accommodate, inflation is zero in this regime. It is now easy to see that

$$\frac{\partial y_t^{pc}}{\partial \delta_i} < 0, \forall 0 < \bar{g} < 1, i = 1, 2. \quad (3.31)$$

(3.31) corresponds to the Calmfors (1982) result, where the accommodation policy can have perverse effects on output when the government faces the monopoly union. In our model, the logic of this result stems from the fact that when the government is willing to accommodate through tax cuts, it becomes less costly for the monopoly union to increase nominal wage.<sup>40</sup> If the monetary authority assigns positive weight on output and/or public expenditure, it is still true that  $\frac{\partial y^{pc}}{\partial \delta_1} > 0$ . However, output deviates then less from the target but higher output comes with the costs of higher inflation.

Let us next analyse the case where labour markets are highly decentralised or, in other words, competitive and central bank is still conservative. This situation can be analysed by setting  $\gamma = \frac{1}{N}$  and  $\beta_i = 0$ . This yields,

$$\sigma_{pc} = \frac{\frac{\delta_1}{N}}{2(\delta_2 + \delta_1) - \frac{\delta_1}{N}} \quad (3.32)$$

$$\frac{\partial \sigma_{pc}}{\partial \delta_1} > 0, \forall \delta_2 > 0 \quad (3.33)$$

$$\varphi_{pc} = \frac{\delta_2 + \delta_1}{2(\delta_2 + \delta_1) - \frac{\delta_1}{N}} \quad (3.34)$$

$$\frac{\partial \varphi_{pc}}{\partial \delta_1} > 0, \forall \delta_2 > 0. \quad (3.35)$$

Equilibrium output is then

$$y_t^{pc} = 1 - \delta_2 \frac{\bar{g}(\delta_2 + \delta_1(1 - \frac{1}{N})) + \frac{\delta_1}{N}}{(\delta_2 + \delta_1)(2\delta_2 + \delta_1(1 - \frac{1}{N}))}. \quad (3.36)$$

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<sup>40</sup>Calmfors (1982) studied the game situation that occurs when unions choose wages and the government implements an employment enhancing policy. He obtains the result that when cooperating (or centralized) trade unions integrate these government policies into their strategic behavior, the end result may be that more unemployment occurs.



This is complicated expression, but we have proved in appendix C an interesting result that

$$\frac{\partial y^{pc}}{\partial \delta_1} > 0, \bar{g} > \frac{2}{1+N} \quad (3.37)$$

$$\frac{\partial y^{pc}}{\partial \delta_1} < 0, 0 < \frac{\delta_1}{\delta_2} < \tilde{\delta}_1, \forall \bar{g} < \frac{2}{1+N} \quad (3.38)$$

$$\frac{\partial y^{pc}}{\partial \delta_1} > 0, \frac{\delta_1}{\delta_2} > \tilde{\delta}_1, \forall \bar{g} < \frac{2}{1+N}. \quad (3.39)$$

(3.37) implies that when the labor markets are highly decetralized and the target public expenditure is sufficiently high, more accommodative policy leads better outcome in terms of output. However, if the public expenditure target is less than given in (3.37) there is a positive range of  $\delta_1$ , where accommodation has perverse effect on output. Typically, it can be shown that this threshold value  $\tilde{\delta}_1$  is small and depends upon number of unions. Moreover, notice that, when the number of unions increases the  $\frac{\partial y^{pc}}{\partial \delta_1} > 0$  condition holds for smaller values of  $\bar{g}$  so that at the limit, when  $N \rightarrow \infty$ ,  $\frac{\partial y^{pc}}{\partial \delta_1} > 0$  holds always.

These results are in contrast with the usual results, because they imply *that the government's intervention may have desirable results, even if the private agents have perfect foresight*. The result is due to the fact that the government's active accommodation policy reduce the distortion arising from the labor markets, while at the same time, the competing unions are not able to take the fiscal accommodation fully into account through the tax cuts. Moreover, it is interesting to note that although labor markets are competitive, the strategic interaction and the wage setters' concern on aggregate outcomes makes them behave differently when compared to the Nash game. This is again due to the strategic advantage of the first mover in the game. These results also highlight the fact that Calmfors (1982) result is specific to the assumption of monopoly union and single policymaker.

Finally let us analyse an intermediate case, where labor market distortions are highest. This can be done by setting  $\gamma = \frac{1}{N^2}$ . Then we have that

$$\sigma_{pc} = \frac{(N-1)^2 + \frac{N\delta_1}{\delta_2 + \delta_1}}{N^2 + N - 1 + \frac{N\delta_2}{\delta_2 + \delta_1}} \quad (3.40)$$

$$\frac{\partial \sigma_{pc}}{\partial \delta_1} > 0, \forall N > 1 \quad (3.41)$$

$$\frac{\partial \sigma_{pc}}{\partial \delta_2} < 0 \quad (3.42)$$

$$\varphi_{pc} = \frac{N^2}{N^2 + N - 1 + \frac{N\delta_2}{\delta_2 + \delta_1}} \quad (3.43)$$

$$\frac{\partial \varphi_{pc}}{\partial \delta_1} > 0, \forall N > 1 \quad (3.44)$$

$$\frac{\partial \varphi_{pc}}{\partial \delta_2} < 0, \forall N > 1. \quad (3.45)$$

Output then becomes

$$y_t^{pc} = 1 - \frac{N^2 \delta_2}{(N + 2N - 1)\delta_2 + (N - 1)\delta_1}. \quad (3.46)$$

Similarly with the case of highly decentralized wage bargaining, it can be shown that there exists some critical level of public expenditure after which a more accommodative government can improve the output level (see appendix C for proof). Moreover, when  $\bar{g}$  is smaller than some threshold value, as given in (3.47) it can be shown that there is some positive value of  $\delta_1$ , where the derivative  $\frac{\partial y_t^{pc}}{\partial \delta_1}$  changes sign from negative to positive. Compared with the competitive case, it can be shown that this critical level of public expenditure is higher.

$$\frac{\partial y_t^{pc}}{\partial \delta_1} > 0, \bar{g} > \frac{(5N - 4)N + 1}{(4(N - 1) + N^2)N + 1}. \quad (3.47)$$

### 3.5.2 Discretionary central bank

In order to complete analysis, we will have a brief look at the case where the government retains control over the central bank. That is, we set  $\beta_i = \delta_i$ . In the case of monopoly union, it can be shown that

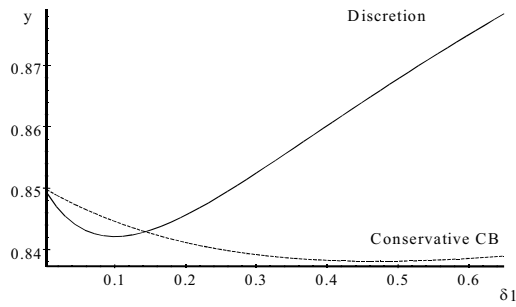
$$\frac{\partial y_t^{pc}}{\partial \delta_1} < 0 \quad (3.48)$$

$$\frac{\partial y_t^{pc}}{\partial \delta_2} > 0, \forall 0 < \bar{g} < 1. \quad (3.49)$$

Interestingly, when the government assigns more weight to the public expenditure target, output deviates less from the target. However, this comes with the costs of higher inflation. When the government assigns infinite weight to the public expenditure target output approaches some value that is less than the target output, however. It can be shown that in the case of a discretionary central bank, output is always lower and inflation higher compared with the independent central bank case.

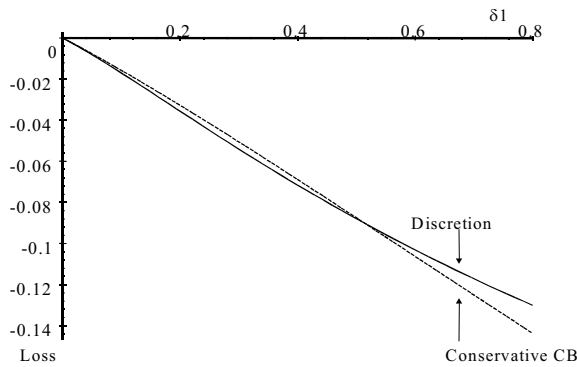
More interestingly, when we allow decentralized labor markets we find that the appointment of the weight conservative central bank is not necessarily better for the economy, in terms of output. In fact, there is a range of values for  $\delta_1$  where the appointment of weight conservative central banker can result in lower output when compared with the discretionary one. Our empirical results from Chapter 2 provided some support to this result. It was found out that unemployment tend to be higher in the countries where price stability objective of the central bank was emphasised in the status of the central bank. This threshold value for  $\delta_1$  depends crucially upon labor market structure and the level of target expenditure. Unfortunately, expressions are too complex to obtain attractive analytical results, so that we illustrate this result graphically in the one special case in figure 3.1. However, it can be shown that the loss of the government can be lower when the central bank is weight conservative and even if the output loss is substantial. This is due to the fact that a discretionary central bank creates inflation, which in turn decreases the utility of the government. This has been illustrated graphically in figure 3.2.

Figure 3.1 **Output in the case of discretionary central bank and weight conservative central bank**



Notes: In this figure we have set  $\delta_2 = 1$ ,  $N = \frac{1}{\gamma} = 3$ ,  $\bar{g} = .3$ . The horizontal axis is  $\delta_1$  and the vertical axis is output.

Figure 3.2 **Loss of the government in the case of discretionary and weight conservative central bank**



Notes: In this figure the solid line refers to the case of discretionary central bank and the dashed line to the case of weight conservative central bank when the labor markets are competitive. In addition we have set  $\delta_2 = 1$ ,  $N = \frac{1}{\gamma} = 3$ ,  $\bar{g} = .3$ . The horizontal axis is  $\delta_1$  and the vertical axis is loss of the government.

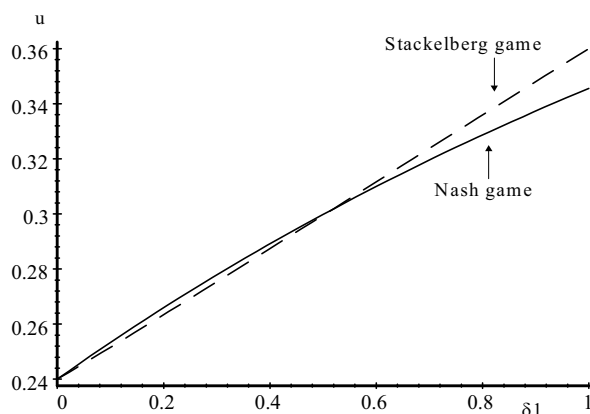
These important results highlight the fact that the central bank and the government must agree upon the relative importance of the targets. If the government is sufficiently conservative with respect to inflation, meaning it has a small  $\delta_1$ , the appointment of the weight conservative central bank is beneficial in terms of output and also in terms of the government's utility. On the contrary, if the government itself puts too much emphasis on the output target, output will be lower when it appoints a weight conservative central bank and labor markets are decentralized. Moreover, even if the appointment of a weight conservative central bank leads to high output loss, for relatively moderate values of  $\delta_1$  this output loss is offset by the fear of increased inflation in the case of a discretionary central bank. More practically, this implies that sufficiently hard-nosed governments are willing to appoint a weight conservative central bank, regardless of the high output loss. These results are in line with Fischer (1994), who argues that it makes little sense to appoint weight conservative central bank for the countries where law is flouted and the financial institutions undeveloped.

### 3.6 Wage setters leadership v.s. discretion

Finally, we wish to draw attention to another interesting result. Namely it can be shown that the utility of the individual unions can be lower in the Stackelberg game, compared with the Nash game, as illustrated in the figure 3.3.

Figure 3.3. illustrates an important result that the union's leadership can in fact be inferior for the unions at moderately low values of  $\delta_1$ , when the central bank is weight conservative and the wage bargaining is decentralized. Hence, *a sufficiently moderate concern by policymakers' for output can make the union's leadership Pareto inferior.*

Figure 3.3. **Utility of the Wage Setters in the Nash Game and Stackelberg Game**



Notes. In this figure we have set  $\gamma = \frac{1}{4}$ ,  $N = 2$ ,  $\delta_2 = 1$ ,  $\beta_1 = \beta_2 = 0$ ,  $\bar{g} = .6$ . The horizontal axis is  $\delta_1$  and vertical axis is utility of the unions.

As rational agents do not have incentives to agree on a Pareto inferior-contract, the unions' leadership under these circumstances may not be a subgame perfect Nash equilibrium of the game. A relevant implication of the latter result is that when the government is sufficiently hard nosed, the government can force the unions to follow a Nash strategy by signalling that it is not willing to accommodate and by appointing a weight conservative central bank. Since also the government would be better off in the Nash equilibria, when compared with unions leadership the whole society might prefer discretionary equilibria. When the central bank is discretionary this same result still holds, the difference being that the threshold value of  $\delta_1$  is smaller.

### 3.7 Concluding comments

The basic point of this Chapter has been to stress simplification of the private sector's behavior and the assumption of a single policymaker, implicit in stylized Barro and Gordon (1983a,b) policy model. Positive policy prescriptions from this model, such as those relative to institutional

design are therefore unreliable. Given that in many European economies the labor market imperfections are present and unions play a role in wage setting, as clarified in Chapters 1 and 2, we believe that the model presented in this Chapter captures the interaction between the private sector and the policymakers in the unionized economies more accurately.

In particular, we have demonstrated that discretionary policy may have favorable effects on overall macroeconomic performance, even if the government's incentives were fully taken into account in the private sector's behavior. The appointment of a conservative central banker, in terms of output is detrimental for an economy with decentralized wage setting, if the government and the central bank disagree strongly the relative importance of the targets. However, when the government is sufficiently hard-nosed and wage bargaining decentralized, regardless of the loss in output, the appointment of a weight conservative central bank can still be Pareto optimal for the government. The last important result of this Chapter is that an individual union's utility can be lower in the Stackelberg game when compared with the Nash game, if the government is sufficiently hard-nosed. This result holds in both cases of a weight conservative and a discretionary central bank.

Finally, although it is not very straightforward to make a direct comparison between the theoretical model analyzed in this Chapter and our empirical results in Chapter 2., the model seemed to be in line with the empirical results by two important aspects. First, it was able to reproduce the Calmfors-Driffill hypothesis. Second, in the union's leadership game wages were conditional on both wage bargaining structure and the preferences of the policymakers. Similarly, deviation of output from the natural rate was conditional on both wage bargaining structure and policymaker's preferences. Our empirical findings implied that unemployment, which could be thought of as a proxy for this deviation was also conditional on both wage bargaining institutions and central bank's independence.

# 4 Inflation Targeting and Wage Bargaining

## 4.1 Introduction

The following Chapter is primarily interested in that how inflation targeting regime functions in unionized economy. As already discussed in Chapter 2, during the 1990s a number of countries adopted a monetary policy framework centered on explicit inflation targets. New Zealand switched into inflation targeting in 1990. Canada followed in February 1991 and the United Kingdom in October 1992 after the collapse of ERM exchange rate band in September 1992. Nordic countries, Sweden and Finland, were forced to search for alternative monetary policy regimes after the dramatic breakdown of their currency peg in autumn 1992. Sweden and Finland adopted inflation targeting in January 1993 and February 1993 respectively. Australia introduced an inflation target in April 1993, Mexico in September 1994 and Spain in summer 1994.<sup>41</sup>

One common characteristics to those countries that adopted inflation targeting regimes have been a lack of legislative independence of the central bank. We have argued that adoption of inflation targeting has basically implied full instrument independence and that it could be seen as a substitute for the lack of legislative independence. Our empirical results in Chapter 2 provided some support for the fact that inflation targeting has proved fairly succesful in bringing down inflation without real costs, thus supporting the argument that granting full instrument independence for the central bank improves the credibility of its policy.

Another common characteristics for inflation targeting countries is that they had also undergone an important phase of labor market reforms prior to monetary reform. Australia, Finland, New Zealand, Sweden,

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<sup>41</sup>For more detailed description and discussion see for instance McCallum (1996).



United Kingdom and Spain have all moved towards more decentralized wage bargaining structure. We have discussed these important reforms in Chapter 2. Canada serves as an interesting polar case, where the wage bargaining has traditionally been decentralized.

Finally, during the labor market reforms and at the time when the formal announcements about inflation targeting were made, many of the countries were governed by the conservative governments. After the reforms, there has been a clear shift from right-wing governments to left-wing governments, but there has been no attempt to restore centralized bargaining nor to abandon an inflation targeting regime. Moreover, in many of the countries decentralization has also been approved by the unions.<sup>42</sup>

Although, it is likely that a sequence of these important reforms has not been deliberate it is useful to analyze an interaction between wage bargaining, adoption of inflation targeting, and government's conservativeness. Consequently, this Chapter extends the inflation targeting model of Svensson (1997) by accounting for different wage bargaining systems similarly with the model in Chapter 3. We also analyze the implications of wage setter's leadership on inflation targeting regime. This is again motivated by empirical evidence from Chapter 2. However, we do not consider the role of fiscal policy and concentrate on monetary policy solely. This simplifies the analysis and allows us to draw straightforward analytic results.

The model that follows, shows that when the central bank is targeting optimally, and wage setters precommit to one year wage contracts, inflation can reach the target level, but output will deviate from the target level of the government by an amount that depends upon weight that the central bank attaches to output stabilization and size of the distortion in the labor markets. Similarly, even in the conventional case of precommitment of the government without inflation targeting, inflation will reach the target but output will still deviate from the natural rate. Contrary to the conventional wisdom, inflation targeting might not be the best way to achieve and maintain low and stable inflation due to the high costs in terms of output losses in an economy where wage bargaining is subject to genuine conflicts of interest.

The following model also predicts that government which attaches only a modest weight to output stabilization prefers to decentralize the

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<sup>42</sup>See table D in appendix D.

wage setting prior to adoption of inflation targeting regime. If the wage setting is sufficiently decentralized an inflation targeting regime is preferred independently of the government's type. This seems to fit the facts well given the sequence of labour market and monetary reforms in the inflation targeting countries, as discussed above and in more detail in Chapter 2.

The rest of the Chapter is organized as follows. In section 2 we describe the basic setup of the model. Section 3 analyzes the conventional cases of discretion and commitment to an optimal rule. Section 4 analyzes a case where the wage setters' precommit i.e. act as leaders of the game. Section 5 analyses the explicit inflation targeting regime both with and without wage setters' commitment and makes a comparison to discretionary regime in terms of the government's losses. Section 6 concludes and discusses some implications of the derived results for the EMU.

## 4.2 The model

The model we develop extends that of Svensson (1997). The main difference is due to the fact that we model the private sector as composed of monopolistic unions who set the nominal wage. Svensson (1997) followed the conventional approach where the private sector forms rational expectations and minimizes expectational errors. Moreover, in our model a time inconsistency problem arises due to the conflict among wage setters and not among the policymakers and the private sector as in Svensson (1997). Therefore, we do not need to make an ad hoc assumption that the policymaker has an overambitious output target. In addition to conventional cases of discretion, precommitment of the government and explicit inflation targeting, where the government (or the central bank) acts as the leader of the game, we also analyze the situation where the wage setters (unions) precommit prior to the actions of the government.

The firms' behavior is characterized by the following aggregate supply equation

$$y_t = \bar{y} + p_t - w_t + \epsilon_t \quad (4.1)$$

$y_t$  is log of the output at time  $t$ ,  $\bar{y}$  is log of the natural rate of output,  $p_t$  is log of the price level,  $w_t = \frac{1}{N} \sum_{i=1}^N w_{it}$  is average wage level and  $\epsilon_t$  is a

supply shock with  $E(\epsilon_t) = 0$  and  $E(\epsilon_t^2) = \nu^2$ . There are  $N$  monopolistic unions (wage setters) in the economy and each one has the following utility function ( $u_{it}$ )<sup>43</sup>

$$u_{it} = l_{it} + (w_{it} - p_t^e)l_{it} \quad (4.2)$$

$$l_{it} = \frac{y_t}{N} - \gamma_i(w_{it} - w_t) \quad (4.3)$$

$$w_t = \frac{1}{N} \sum_{i=1}^N w_{it}. \quad (4.4)$$

Unions care about log of labor share ( $l_{it}$ ) and log of real wage bill ( $w_{it} - p_t^e$ ) $l_{it}$ . The labor share of the each union depends upon aggregate labor demand, which in turn depends linearly on aggregate supply under an assumption of constant returns to scale, as well as the relative wage ( $w_{it} - w_t$ );  $\gamma_i > 0$  reflects the monopoly power of each union. We restrict  $\gamma_i < \frac{1}{N}$ . This has an implication that each union has some monopoly power. Clearly, when  $\gamma_i \rightarrow \frac{1}{N}$ , monopoly power of the union decreases.

Unions set the wage for period  $t$  before the output shock occurs and they have rational expectations. Each union solves

$$\max_{w_{it}} E_0 \left( \sum_{t=1}^{\infty} \rho^{t-1} u_{it} \right) \quad (4.5)$$

subject to relevant constraints.

We assume that each union holds the same expectations about the price level and that each union has rational beliefs about the other unions. That is

$$p_{it}^e = E_{t-1}^i p_t = E_{t-1} p_t = p_t^e \quad (4.6)$$

$$E^{-i} w_j = w_j \quad (4.7)$$

$p_{it}^e$  denotes expectation of the price level of the union  $i$ .  $E_{t-1}$  denotes expectation conditional upon information available in period  $t - 1$ , which includes the realization of all variables up to and including period  $t - 1$ , as well as constant parameters of the model.  $E^i$  denotes expectations of the union  $i$  and  $E^{-i}$  denotes beliefs that the other unions have about others. In this model, these beliefs are perfect, rational and symmetric. There are no information asymmetries and all the unions are similar. The log of the

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<sup>43</sup>Form of the utility function is similar to Akhand (1992).

long-run natural level of output will be set for convenience and without loss of generality equal to 1.

The government is assumed to minimize

$$V_t = E_0 \left[ \sum_{t=1}^{\infty} \beta^{t-1} L_t \right] \quad (4.8)$$

where

$$L_t = \frac{1}{2} [(\pi_t - \pi^*)^2 + \lambda(y_t - y^*)^2]$$

$\pi_t = p_t - p_{t-1}$  is inflation at time  $t$  and  $\pi^*$  and  $y^*$  are the target levels of inflation and output respectively.  $\lambda \geq 0$  is the weight that the government assigns to output stabilization.

An inflation targeting regime is interpreted as a delegation of monetary policy to the central bank with an assigned loss function

$$L_t^{cb} = \frac{1}{2} [(\pi_t - \pi^{cb})^2 + \lambda(y_t - y^{cb})^2]. \quad (4.9)$$

The targets  $\pi^{cb}$  and  $y^{cb}$  may differ from the corresponding parameters in a general loss function ( $V_t$ ), while  $\lambda$  is the same in both loss functions. The fact that  $\lambda$  is same for the central bank and the government reflects the lack of legislative independence of the central banks in inflation targeting countries. This assumption can be easily relaxed, though. Contrary to the Svensson (1997), we assume that the government targets natural rate i.e.  $y^* = 1$ . Therefore, we do not need to make an ad hoc assumption as to why the government's targeted output is above the actual natural rate. Although the output target of the central bank may differ from the target of the government, our main results are derived under the assumption that  $y^{cb} = y^* = 1$ . The central bank is assumed to have perfect control over inflation rate  $\pi_t$ . It sets the inflation rate each period after having observed the current supply shock  $\epsilon_t$ . This assumption that the central bank has a perfect control over inflation is perhaps unrealistic but convenient. The introduction of an instrument, such as money supply, by which inflation were controlled would allow us to consider the effects of a demand (or velocity) shock to the economy. Persson and Tabellini (1997), however, show that demand shocks can be fully offset by policymakers, provided that the policymaker's loss function is as given in (4.8) and that there are no information asymmetries. Abstracting from the issue of controllability

of money supply in the stochastic economy, controlling inflation by the instrument (money supply) or controlling inflation directly is effectively equivalent.

Notice also that we assume that both the unions and the government observe the natural rate  $\bar{y}$  before action. The fact that only the policymakers observe the supply shock implies that they have a better knowledge of the state of the economy and that they can react “more flexibly” to these changes when compared with wage-setters. This informational advantage allows policymakers to stabilize the economy.

## 4.3 Conventional cases

### 4.3.1 Commitment to an optimal rule

We will next analyze different regimes in turn. First, consider a situation when the central bank is directly controlled by the government, so the government can choose inflation rate in each period, conditionally upon the observed supply shock. Furthermore, assume that the government can commit to a state contingent rule for inflation rate. Without output persistence or any other intertemporal link the problem of minimizing the intertemporal loss function is equivalent to the static problem of minimizing the expected one period loss function. In this set up the minimization problem can be formulated as follows

$$\begin{aligned} & \min_{p_t, p_t^e} E_{t-1} [L_t] \\ & \text{s.t.} \\ & y_t = 1 + p_t - w_t + \epsilon_t \\ & w_t = w_t(p_t^e) \\ & p_t^e = E_{t-1} p_t. \end{aligned}$$

The government internalizes the effect of its policy on the nominal wage rule  $w_t = w_t(p_t^e)$ . This is the wage rule that results from the unions’ maximization problem.

Following Svensson (1997), under the precommitment to a state

contingent rule, the government's Lagrangian ( $\mathcal{L}_t$ ) can be written

$$\mathcal{L}_t = E_{t-1} \left[ \frac{1}{2} [(\pi_t - \pi^*)^2 + \lambda(p_t - w_t(p_t^e) + \epsilon_t)^2] - \theta_{t-1} (p_t^e - E_{t-1}p_t) \right] \quad (4.10)$$

where  $\pi_t = p_t - p_{t-1}$ , and  $\theta_{t-1}$  is Lagrange multiplier. The first order conditions with respect to  $p_t$  and  $p_t^e$  respectively are

$$p_t - p_{t-1} - \pi^* + \lambda(y_t - 1) + \theta_{t-1} = 0$$

$$-E_{t-1} [\lambda(y_t - 1)] w_t'(p_t^e) - \theta_{t-1} = 0$$

where  $w_t'(p_t^e) = \frac{\partial w_t}{\partial p_t^e}$ . Eliminating the Lagrange multiplier, we obtain

$$p_t - p_{t-1} - \pi^* + \lambda(y_t - 1) - E_{t-1} \lambda(y_t - 1) w_t'(p_t^e) = 0. \quad (4.11)$$

Taking expectations at  $t - 1$  yields

$$E_{t-1} p_t - p_{t-1} - \pi^* + E_{t-1} \lambda(y_t - 1) - E_{t-1} \lambda(y_t - 1) w_t'(p_t^e) = 0. \quad (4.12)$$

In order to find  $w_t'(p_t^e)$ , we need to consider the union's problem. In each period  $t$ , union  $i$  faces the same optimization problem and because there is no intertemporal link, maximization of (4.5) is the same as maximizing the one period utility.

The union  $i$ 's optimization problem is therefore

$$\max_{w_{it}} E_{i,t-1} (1 + w_{it} - p_t) \left( \frac{y_t}{N} - \gamma_i (w_{it} - w_t) \right) \quad (4.13)$$

s.t.

$$y_t = 1 + p_t - w_t + \epsilon_t$$

The unions act simultaneously among themselves and they form rational expectations about the government's policies i.e. price level  $p_t$ . Solving the first order conditions and imposing symmetry ( $\gamma_i = \gamma_j = \gamma$ ) yields (the derivation is given in appendix E)

$$w_t = p_t^e + \sigma_h \quad (4.14)$$

$$\sigma_h = \frac{(1 - N\gamma)(N - 1)}{1 + (\gamma(N - 1) + 1)N} \quad (4.15)$$

$\sigma_h$  stands for *the real wage bias*. It can be shown that  $\sigma_h \in (0, 1)$ , as long as  $N < \frac{1}{\gamma}$ , i.e. as long as each union has some monopoly power in the wage setting.

Because the unions have rational expectations of the government's policy, we can write

$$w_t = E_{t-1}p_t + \sigma_h. \quad (4.16)$$

Taking expectations at  $t - 1$  of the government's problem and substituting into the wage rule, yields

$$w_t = p_{t-1} + \pi^* - E_{t-1}\lambda(y_t - 1) \left[ 1 - w'_t(p_t^e) \right] + \sigma_h. \quad (4.17)$$

Realizing that  $w'_t(p_t^e) = 1$ , in the optimal wage rule (4.14), the final form of the optimal wage rule is

$$w_t^c = p_{t-1} + \pi^* + \sigma_h. \quad (4.18)$$

where

$$p_{t-1} + \pi^* = E_{t-1}p_t.$$

Combining now (4.1), (4.11) and (4.14) we obtain the optimal decision rule of the government

$$\pi_t^c = \pi^* - \frac{\lambda}{1 + \lambda} \epsilon_t \quad (4.19)$$

The superscript  $c$  stands for commitment. Given the optimal inflation rule (4.19) and the wage rule (4.18), output will satisfy

$$y_t^c = 1 - \sigma_h + \frac{1}{\lambda + 1} \epsilon_t. \quad (4.20)$$

Contrary to the usual results, even in the commitment case *average output is below the desired rate of unity, by an amount that depends upon the size of the distortion in the labor markets* ( $\sigma_h$ )<sup>44</sup>. Without distortions in the labor markets, i.e. when  $\sigma_h = 0$ , average output will be at its target level. This happens when  $N = 1$  or when  $\gamma = \frac{1}{N}$ . The first case can be interpreted as the case of an economy wide monopoly union. The second

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<sup>44</sup>See Chapter 3 for detailed characteristics of this term.

one could be interpreted as competitive, completely decentralized case of wage bargaining.

Regardless of the fact that output still deviates from the target, this situation is clearly the first best for the government at the given labor market structure. However, notice that neither a deviation of output from the target or wage does depend upon accommodation parameter  $\lambda$ . On the one hand, this result emphasizes the fact the deviation of output from the target can be due to structural problems in the labor markets, where stabilization policy cannot influence. On the other hand, since empirical results in Chapter 2 showed that both wage growth and unemployment were conditional on central bank independence, the prediction of the model is not in line with empirical evidence.

As usual, precommitment to an optimal state contingent rule is time-inconsistent. This can be easily seen by noticing that the ex ante precommitment policy is sub-optimal ex post. Evaluating an expected marginal gain of “surprise inflation” at given  $w_t^c$  we find that

$$\frac{\partial E_{t-1} L(\pi, y)}{\partial \pi_{|w_t=w_t^c}} = E_{t-1} [(1 + \lambda) (\pi_t - \pi^*) - \lambda \sigma_h + \epsilon_t].$$

Substituting in the optimal inflation rule  $\pi^c$ , we find that

$$\frac{\partial E_{t-1} L(\pi, y)}{\partial \pi_{|w_t=w_t^c, \pi_t=\pi_t^c}} = -\lambda \sigma_h \leq 0. \quad (4.21)$$

When  $\sigma_h > 0$  and  $\lambda > 0$  expansion (surprise inflation) reduces the loss of the government. Precommitment is therefore time inconsistent. This is the typical result.

Expected utility of the each union, in turn, will be

$$E [u_{it}^c] = \frac{1}{1 - \rho} \frac{1}{N} \left( 1 - \sigma_h^2 + \frac{\lambda}{(1 + \lambda)^2} \nu^2 \right). \quad (4.22)$$

Ex post utility of the unions depends upon the accommodation parameter  $\lambda$ , the structure of the labor markets and the variance of output shock. The expected loss of the government in turn is

$$E [V_t^c] = \frac{1}{1 - \beta} \frac{1}{2} \left( \lambda \sigma_h^2 + \frac{\lambda}{1 + \lambda} \nu^2 \right). \quad (4.23)$$



### 4.3.2 Discretion

Assume now that the government still retains control of the central bank, but that it cannot commit to a state contingent rule, due to the time-inconsistency problem. The government chooses  $\pi_t$  in each period  $t$  so as to minimize the one period loss function  $L_t$  subject to the supply equation, disregarding the wage setting behavior of the unions. In other words, the government sets its policy after wages and expectations have been formed. Unions behave as before.

The first order condition for the government (central bank) is then simply

$$\pi_t - \pi^* + \lambda(p_t - w_t - \epsilon_t) = 0 \quad (4.24)$$

Taking expectations at  $t - 1$  gives

$$E_{t-1}p_t = \frac{1}{1 + \lambda} [p_{t-1} + \pi^* + \lambda E_{t-1}w_t]. \quad (4.25)$$

Combining this with

$$\begin{aligned} w_t &= p_t^e + \sigma_h \\ p_t^e &= E_{t-1}p_t \end{aligned}$$

and substituting into the wage rule, yields

$$w_t = \frac{1}{1 + \lambda} [p_{t-1} + \pi^* + \lambda E_{t-1}w_t] + \sigma_h. \quad (4.26)$$

Taking expectations at  $t - 1$  yields

$$E_{t-1}w_t = p_{t-1} + \pi^* + (1 + \lambda) \sigma_h. \quad (4.27)$$

Substituting this in turn back into the (4.25) yields

$$E_{t-1}p_t = p_{t-1} + \pi^* + \lambda \sigma_h$$

which from the wage rule implies

$$w_t^d = p_{t-1} + \pi^* + (1 + \lambda) \sigma_h. \quad (4.28)$$

Finally we find the optimal inflation rule

$$\pi_t^d = \pi^* + \lambda\sigma_h - \frac{\lambda}{1+\lambda}\epsilon_t. \quad (4.29)$$

Given the optimal decision rules (4.28) and (4.29) output will be determined by

$$y_t^d = 1 - \sigma_h + \frac{1}{\lambda+1}\epsilon_t. \quad (4.30)$$

Output will behave similarly under discretion and under commitment. This is because real wages will be the same in the discretionary and in the commitment regimes. However, expected inflation is higher in the discretionary regime by an amount that depends upon magnitude of the distortion in the labor markets and the weight that the government attaches to the target level of output. More precisely,

$$\pi_t^d - \pi_t^c = \lambda\sigma_h.$$

This is a typical result, where higher inflation does not yield any output gain. Notice however, that as in the commitment case, the average level of output does not depend upon the degree of accommodation ( $\lambda$ ), while high inflation is partially related to the incentive problem of the policymakers ( $\lambda$ ) as well as wage bargaining structure.

The policy response to the supply shock  $\epsilon_t$  is similar under discretion and under precommitment. This equivalence is specific to the static setup of the model and as shown by Svensson (1997) and discussed by Persson and Tabellini (1997) does not carry over to a dynamic model where output is serially correlated. In the dynamic model, the future inflation bias depends upon current output. This leads to the situation where the policymaker responds more aggressively to supply shocks under discretion than under precommitment.

The government's expected loss under discretion will be

$$E[V_t^d] = \frac{1}{1-\beta} \frac{1}{2} \left( \lambda\sigma_h^2(1+\lambda) + \frac{\lambda}{1+\lambda}\nu^2 \right) > E[V_t^c]. \quad (4.31)$$

The expected utility of the unions under discretion will be

$$E(u_{it}^d) = \frac{1}{1-\rho} \frac{1}{N} \left( 1 - \sigma_h^2 + \frac{\lambda}{(1+\lambda)^2}\nu^2 \right) = E(u_{it}^c). \quad (4.32)$$

Notice that while the government is worse off under discretion, wage setters are indifferent between discretionary and commitment regimes. The unions are indifferent because they do not care about the level of inflation, but only about the real wage and output. The government, on the other hand, is worse off because it also cares about inflation, which is higher in the discretionary regime when compared with the precommitment regime.

## 4.4 Wage setters' leadership

Consider now a regime in which the wage setters are able to precommit in the sense that they take into account the effect of their action on inflation. This is the same as thinking that unions act as Stackelberg leaders of the game, precommitting to the one year wage contract prior to the government's action. The maximization problem of the unions can now be written

$$\begin{aligned} & \max_{w_{it}} E_{t-1} (1 + w_{it} - p_t) \left( \frac{y_t}{N} - \gamma_i \left( w_{it} - \frac{1}{N} \sum_{i=1}^N w_{it} \right) \right) \\ & s.t. \\ & y_t = 1 + p_t - w_t + \epsilon_t \\ & E_{t-1} p_t = p_t^e = \frac{1}{1 + \lambda} [p_{t-1} + \pi^* + \lambda E_{t-1} w_t]. \end{aligned}$$

The second constraint is the expected value of the government's first order condition under discretion (4.25). The difference from the conventional case analyzed so far is that each union responds to the expected optimal state contingent rule of the government, that depends upon the economy-wide wage level ( $w_t = \left( \frac{1}{N} \sum_{i=1}^N w_{it} \right)$ ). Due to this feedback effect, unions are able to "exploit" the government's desire to accommodate when  $\lambda > 0$ .

Solving the maximization problem, imposing symmetry and re-expressing yields the linear optimal wage rule

$$w_t^{pc} = p_{t-1} + \pi^* + (1 + \lambda) \sigma_{pc} \quad (4.33)$$

$$\sigma_{pc} = \frac{(N - 1)(1 - \gamma N)}{\left( \frac{1 - \lambda}{1 + \lambda} + N(\gamma(N - 1) + 1) \right)}. \quad (4.34)$$

Superscript  $pc$  stands for the private sector's (wage setters') commitment. The term  $\sigma_{pc}$  represents real wage bias.  $\sigma_{pc}$  includes the parameter  $\lambda$ , and differs from  $\sigma_h$  in (4.15) only by the term  $\frac{1-\lambda}{1+\lambda}$  which replaces 1 in the denominator of  $\sigma_h$ . Since  $|\frac{1-\lambda}{1+\lambda}| \leq 1$ , it is clear that  $\sigma_{pc} \geq \sigma_h \geq 0$ .

Moreover, it is easy to show that  $\frac{\partial \sigma_{pc}}{\partial \lambda} \geq 0$ . This implies that the more the government is concerned with output stabilization the higher will be the real wage bias.

Turning back to the government's problem, the government's optimal wage rule (under discretion) must satisfy

$$\pi_t - \pi^* + \lambda(p_t - w_t + \epsilon_t) = 0.$$

Substituting the optimal wage rule (4.33) yields

$$\pi_t^{pc} = \pi^* + \lambda\sigma_{pc} - \frac{\lambda}{1+\lambda}\epsilon_t. \quad (4.35)$$

Using the optimal decisions rule (4.33) and (4.35) we finally find that output is determined by

$$y_t^{pc} = 1 - \sigma_{pc} + \frac{1}{1+\lambda}\epsilon_t. \quad (4.36)$$

Remembering that the average output under discretion and commitment satisfied

$$y_t^d = 1 - \sigma_h = y_t^c$$

it is easy to see that

$$y_t^c = y^d > y^{pc}, \forall \lambda > 0, N < \frac{1}{\gamma}. \quad (4.37)$$

Therefore, *for all positive  $\lambda$  output is always higher under discretion or under precommitment of the government than under precommitment of the wage setters.*

Comparing inflation rates, we find that

$$\pi_t^{pc} > \pi_t^d > \pi_t^c, \forall \lambda > 0, N < \frac{1}{\gamma}. \quad (4.38)$$

Clearly, the unions' precommitment case is worst when compared with discretion and the government's precommitment. Notice also that even if

the government did not care about output stabilization ( $\lambda = 0$ ), output would still deviate from the target, similarly to the discretionary case. However, inflation could reach the target level, if the government would attach zero weight on output stabilization. Precommitment of the unions is also time-inconsistent<sup>45</sup>. This can be seen by evaluating the expected marginal gain of utility of the unions at a given  $\epsilon_t$  and given  $\pi_t^{pc}$  at equilibrium point  $w_t^{pc}$ . It can be shown that<sup>46</sup>

$$\frac{\partial E_t(u_{it})}{\partial w_t | \pi_t = \pi_t^{pc} | w_t = w_t^{pc}} < 0 \quad \forall \lambda > 0 \quad N < \frac{1}{\gamma}. \quad (4.39)$$

The implication of (4.39) is that if unions could renege on wage contracts, they would set wages lower.

The expected loss of the government will be

$$E(V_t^{pc}) = \frac{1}{1-\beta} \frac{1}{2} \left( (\lambda+1)\lambda\sigma_{pc}^2 + \frac{\lambda}{1+\lambda}\nu^2 \right). \quad (4.40)$$

Therefore, it is clear that

$$E(V_t^{pc}) > E(V_t^d) > E(V_t^c), \quad \forall \lambda > 0, \quad 1 < N < \frac{1}{\gamma}. \quad (4.41)$$

The expected utility of the each individual union will be

$$E(u_{it}^{pc}) = \frac{1}{1-\rho} \frac{1}{N} \left( 1 - \sigma_{pc}^2 + \frac{\lambda}{(1+\lambda)^2} v^2 \right) < E(u_{it}^d) = E(u_{it}^c). \quad (4.42)$$

An important feature of this regime is that the utility of unions under their own precommitment will be lower than in the discretionary and commitment regimes. Therefore, the uncoordinated precommitment of the unions reinforces the desire of each individual union to set its own wage above its rivals. This is due to the government's incentive to stabilize output as it becomes less costly for each union to set the wage above the market clearing level. In other words precommitment of the unions combined with the government's desire to stabilize output enforces the coordination failure. This is also reflected by the time inconsistency result,

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<sup>45</sup>I am indebted to Jouko Vilmunen for noticing that the precommitment of the unions can be time-inconsistent.

<sup>46</sup>See appendix E.

which implies that the unions' utility would be increased if wages were lower at equilibrium. A second important implication is that monetary policy should not be conditioned on the decision variable of the wage setters, when the wage setters act as Stackelberg leaders. This enforces the coordination failure and makes all the players worse off.

Another interesting result is that government policy is not time inconsistent in the usual sense, where the government would find it optimal to increase inflation. Namely, it can easily be shown that for all positive  $\lambda$ , the government would find it optimal to deviate from (4.35) by *moderating inflation*. This result may partially explain the decreasing trend of inflation since the mid 1980s. It could be argued that after governments switched to rule based policies, at the beginning of these periods the wage setters did not know the policy rule of the government and thus took the actions of the policy makers as given, as in the conventional discretionary regime. Over time, then, the wage setters "learned the policy rule" and started reacting to it. At the outset, this may have resulted higher inflation rates but gradually after policymakers realized the response of private sector, they started to moderate inflation, bringing down also the nominal wages. In this vein, an inflation moderation must have become due to the change in the policymakers preferences with regard to output stabilization. Novelty of this result is that while the conventional Barro-Gordon model can only explain rising inflation rates in the 1970s at the given level of output, due to the traditional time inconsistency result, the wage setters' leadership case may offer an explanation for decreasing inflation rates towards the 1990s, as explained above.

## 4.5 Explicit inflation targeting

### 4.5.1 Conventional case

After analysing these conventional cases, consider now assigning explicit inflation and output targets,  $\pi^{cb}$  and  $y^{cb}$ , to the central bank. These targets may differ from the government's target and are assumed to be chosen at "the constitutional stage". We assume that once the targets  $\pi^{cb}$  and  $y^{cb}$  for the central bank are chosen, society can no longer renege on these targets. The possibility of choosing optimal targets for the central bank at

the constitutional stage provides an additional tool for the government to avoid the time inconsistency problem related to the precommitment case. Another advantage of strategic delegation of monetary policy through an explicit inflation target is that government's target inflation can be achieved without the need to compromise the flexibility of the policy.<sup>47</sup>

Let the central bank be assigned the one period loss function

$$L_t^{cb} = \frac{1}{2} (\pi_t - \pi^{cb})^2 + \lambda(y_t - y^{cb})^2$$

$\lambda$  is the same as in the government's loss function.

The central bank's optimization problem is now

$$\begin{aligned} & \min_{p_t} E_{t-1} (L_t^{cb}) \\ & s.t. \\ & y_t = 1 + p_t - w_t + \epsilon_t. \end{aligned}$$

The first order condition for the central bank will be (notice that the central bank acts under discretion)

$$\pi_t - \pi^{cb} + \lambda(y_t - y^{cb}) = 0. \quad (4.43)$$

Taking expectations at  $t - 1$ , substituting  $y_t$  and using  $w_t = E_{t-1}p_t + \sigma_h$  yields

$$E_{t-1}p_t = \frac{1}{1 + \lambda} (p_{t-1} + \pi^{cb} + \lambda w_t + \lambda(y^{cb} - 1)). \quad (4.44)$$

Substituting this into the optimal wage rule (4.14) yields

$$w_t^T = p_{t-1} + \pi^{cb} + \lambda(y^{cb} - 1) + (1 + \lambda) \sigma_h. \quad (4.45)$$

Using this, the first order condition for the central bank and the output equation yields the optimal inflation rule ( $\pi_t^T$ ) in the inflation targeting regime such as

$$\pi_t^T = \pi^{cb} + \lambda(y^{cb} - 1) + \lambda\sigma_h - \frac{\lambda}{1 + \lambda}\epsilon_t. \quad (4.46)$$

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<sup>47</sup>Svensson (1997) shows that the explicit inflation targeting regime mimics the linear inflation contract proposed by Walsh (1995).

When the target inflation rate ( $\pi^{cb}$ ) and the target output ( $y^{cb}$ ) are chosen (optimally) so that

$$\pi^{cb} = \pi^* - \lambda(y^{cb} - 1 + \sigma_h) \quad (4.47)$$

the equilibrium will be the same as in the case of commitment to the optimal rule and inflation can reach the target level ( $\pi^*$ ) desired by the government. In order to focus on optimality of inflation target alone and make a direct comparison to Svensson (1997), we assume now that  $y^{cb} = \bar{y} = 1$ . That is, the central bank's output target coincides with the natural rate of output and the government's output target. Under this assumption, inflation reaches the target level ( $\pi^*$ ) by choosing  $\pi^{cb}$  such that

$$\pi^{cb} = \pi^* - \lambda\sigma_h \quad (4.48)$$

Contrary to Svensson (1997), even if the central bank's output target is the same as the government's output target, output will still deviate from the natural rate by an amount that depends upon labor market distortions ( $\sigma_h$ ), similarly to the case of commitment to the optimal rule. That is,

$$y_t^T = y_t^c = 1 - \sigma_h + \frac{1}{1 + \lambda}\epsilon_t. \quad (4.49)$$

This is, however, the best achievable situation given the labor market structure ( $\sigma_h$ ). Only way to bring output closer on its desired level is to reduce distortion arising from the labor markets.

Not surprisingly, when the government has chosen the optimal inflation target according to (4.47) the government's expected loss will be

$$E[V_t^{Tpc}] = E[V_t^c] = \frac{1}{2} \frac{1}{(1 - \beta)} \left( \lambda\sigma_h^2 + \frac{\lambda}{1 + \lambda} \nu^2 \right). \quad (4.50)$$

The unions' expected utility, in turn, will be

$$E(u_{it}^T) = E(u_{it}^c) = E(u_{it}^d) = \frac{1}{1 - \rho} \frac{1}{N} \left( 1 - \sigma_h^2 + \frac{\lambda}{(1 + \lambda)^2} \nu^2 \right) > E(u_{it}^{pc}). \quad (4.51)$$

The government's expected loss will be the same as in the precommitment case (government), while the unions are indifferent between the precommitment by the government, discretion and an explicit inflation targeting regime.



## 4.5.2 Wage setters' leadership

We will now discuss the most interesting case where the central bank has an explicit inflation and output target and when the wage setters precommits (acts as Stackelberg leader). The motivation for this has been discussed in Chapter 3, where we argued that at least partially centralized wage bargaining institutions may have possibility to precommit. In this regime, each union solves

$$\begin{aligned} & \max_{w_{it}} E_{t-1} (1 + w_{it} - p_t) \left( \frac{y_t}{N} - \gamma_i (w_{it} - w_t) \right) \\ & s.t. \\ & y_t = 1 + p_t - w_t + \epsilon_t \\ & E_{t-1} p_t = p_t^e = \frac{1}{1 + \lambda} (p_{t-1} + \pi^{cb} + \lambda w_t + (y^{cb} - 1)\lambda). \end{aligned}$$

The constraints now are the supply equation and the expected value of the central bank's optimal rule. This maximization problem yields

$$w_t^{Tpc} = p_{t-1} + \pi^{cb} + \lambda (y^{cb} - 1) + (1 + \lambda) \sigma_{pc} \quad (4.52)$$

$$\sigma_{pc} = \frac{(N - 1)(1 - \gamma N)}{\frac{1 - \lambda}{1 + \lambda} + N(\gamma N - \gamma + 1)}. \quad (4.53)$$

Turning back to the central bank's problem, the optimal inflation rule must still satisfy

$$\pi_t - \pi^{cb} + \lambda(y_t - y^{cb}) = 0.$$

Substituting  $y_t$  and the wage rule (4.52) and solving for  $\pi_t$  yields the optimal rule

$$\pi_t^{Tpc} = \pi^{cb} + \lambda (y^{cb} - 1) + \lambda \sigma_{pc} - \frac{\lambda}{1 + \lambda} \epsilon_t. \quad (4.54)$$

The difference from the conventional case of an optimal targeting regime is that instead of  $\sigma_h$ , we have the term  $\sigma_{pc}$ , which depends now also on  $\lambda$ . However, choosing the target  $\pi^{cb}$  such that

$$\pi^{cb} = \pi^* - \lambda (y^{cb} - 1) - \lambda \sigma_{pc} \quad (4.55)$$

the target inflation ( $\pi^*$ ) can be achieved. Notice, however, that whatever the targeting rule of the central bank is, output is determined by

$$y_t^{Tpc} = 1 - \sigma_{pc} + \frac{1}{1 + \lambda} \epsilon_t. \quad (4.56)$$

In this case, output is clearly lower than under (pure) discretion and under the commitment of the government . That is, *although the economy can reach the target level of inflation, it may be with a substantial loss in output, provided the wage setters have committed to one period wage contracts and distortions in the labor markets are not negligible.*

The expected loss of the government, when the target is chosen according to (4.55) is

$$E \left[ V_t^{T_{pc}} \right] = \frac{1}{1-\beta} \frac{1}{2} \left( \lambda \sigma_{pc}^2 + \frac{\lambda}{1+\lambda} \nu^2 \right). \quad (4.57)$$

The expected loss of the unions' is equivalent to the case of precommitment of the wage setters analyzed previously.

It is important to notice that when the wage setters precommit, a stability-flexibility trade-off of monetary policy has not disappeared in the explicit inflation targeting regime. This is evident from the fact that the deviation of output from the target depends also upon accommodation parameter  $\lambda$ . Less accommodation would mean higher output, but this would come with the costs of less flexibility. This has an implication that appointment of conservative central banker is beneficial even in an explicit inflation targeting regime. We have proved this important results in appendix E.

### 4.5.3 Discretionary regime v.s. wage setters' leadership

We next show that optimal inflation targeting with wage setters' precommitment can yield a higher loss when compared with the pure discretionary regime. Therefore, the government and the wage setters and thus society as a whole may prefer the discretionary regime over explicit inflation targeting.

If the government had chosen an optimal target for the central bank such that  $\pi^{cb} = \pi^* - \lambda ((y^{cb} - 1) + \sigma_{pc})$ , the expected loss of the government is

$$E(V_t^{T_{pc}}) = \frac{1}{1-\beta} \frac{1}{2} \left( \lambda \sigma_{pc}^2 + \frac{\lambda}{1+\lambda} \nu^2 \right). \quad (4.58)$$

In the discretionary regime the expected loss was

$$E[V_t^d] = \frac{1}{2} \frac{1}{1-\beta} \left( \lambda \sigma_h^2 (1+\lambda) + \frac{\lambda}{1+\lambda} \nu^2 \right). \quad (4.59)$$

We can now compare the expected losses in the explicit inflation targeting regime and in the discretionary regime. In particular we find that

$$\begin{aligned} E(V_t^{Tpc}) &> E(V_t^d) \\ &\Leftrightarrow \\ \left( \frac{\sigma_{pc}}{\sigma_h} \right)^2 &> 1 + \lambda \end{aligned} \quad (4.60)$$

Using definitions (4.60) can be rewritten as

$$\left( \frac{1 + N(\gamma(N-1) + 1)}{\frac{1-\lambda}{1+\lambda} + N(\gamma(N-1) + 1)} \right)^2 > 1 + \lambda, \quad \forall 1 < N < \frac{1}{\gamma}. \quad (4.61)$$

In the special cases where  $N = 1$  or  $N = \frac{1}{\gamma}$ , the government would be indifferent between targeting and discretion, since in these cases  $\sigma_h = \sigma_{pc} = 0$ . When  $1 < N < \frac{1}{\gamma}$ , in other words, there is some conflict within the wage setters the situation is more complicated. Preference for targeting over discretion depends upon the size of distortion in the labor markets in rather complicated fashion. However, it can be shown that there exist positive range of values for  $\lambda$  where discretion would be preferred over optimal targeting by the government (and also by the wage setters). That is, it can shown that

$$E(V_t^{Tpc}) > E(V_t^d) \text{ for some } \lambda < \tilde{\lambda}(N, \gamma). \quad (4.62)$$

In particular this condition holds when the wage bargaining is fairly centralized ( $N < 3$ ). When the labor markets are decentralized ( $N \geq 3$ ), independently on the weight that the government assigns to the output stabilization, inflation targeting is preferred over discretion. We have also shown that relatively conservative governments, interpreted as having a small  $\lambda$  would prefer a labor market reform prior to a monetary reform. Therefore, there exist a threshold level of decentralization ( $N \geq 3$ ) after which the government, independently on its preferences would prefer the inflation targeting regime. This important result is proved in appendix E. Although the labor market reforms were made most likely independently on the decision to adopt inflation targeting this result emphasizes the necessity of these reforms.

#### 4.5.4 The credibility of the inflation target

The dynamic inconsistency of monetary policy, developed by Kydland and Prescott (1977) and Barro and Gordon (1983a) can be shown to arise in the conventional inflation targeting regimes. Indeed, it is clear that the average actual inflation will exceed the targeted rate ( $\pi^{cb}$ ) and thus using the logic of dynamic inconsistency, such a target cannot be credible. This is due to the fact that the central bank could achieve a lower loss in one-shot game by announcing the chosen optimal target and then subsequently deviating from it. However, as pointed out by McCallum (1995) it is not clear why the central bank should submit to the pressure of dynamic inconsistency. Despite the absence of any precommitment technology, the central bank may nevertheless achieve better results in terms of its preferences by abstaining from the temptation to exploit each period's inconsistency incentives and instead choose a policy that would be optimal if expected inflation were equal to the target rate in repeated interaction with the private sector. Moreover, it is commonly agreed that central banks are nevertheless less closely involved in the political process and thus less likely to be involved in short-sighted policies. McCallum (1996) argues that some central banks in fact do behave in "committed" or "rule-like" fashion.

The existence of mandates or contracts that emphasize inflation prevention make it also more difficult for governments to exert discretionary pressure on their central banks and thus effectively behave in a rule-like or committed fashion. These aspects have been emphasized in Walsh (1995) and Persson and Tabellini (1993).

In the case where the wage setters are precommitted, such a time inconsistency problem is not present in the usual manner since the leadership of the game is given to wage setters. Nevertheless, it can be shown that

$$\frac{\partial E_{t-1} L^g(\pi, y)}{\partial \pi_{|w=w^pc|\pi=\pi^{Tpc}}} = \lambda + \pi^{cb} - \pi^* \quad (4.63)$$

$$\frac{\partial E_{t-1} L^{cb}(\pi, y)}{\partial \pi_{|w=w^pc|\pi=\pi^{Tpc}}} = \lambda \quad (4.64)$$

where  $\pi^{cb}$  is inflation target of the central bank and  $L^g(\pi, y)$  and  $L^{cb}(\pi, y)$  refer to the loss functions of the government and the central bank respectively. While the central bank would prefer moderating inflation

even further for positive  $\lambda$ , independently on the chosen target, the government could set  $\pi^{cb} = \pi^* - \lambda$ , instead of  $\pi^{cb} = \pi^* - \lambda\sigma_{pc}$ . However, in this case the actual inflation would on average be below the target ( $\pi^*$ ), such that

$$E_t \left( \pi_t^{Tpc} - \pi^* \right) = \lambda(\sigma_{pc} - 1) < 0, \forall 1 < N < \frac{1}{\gamma}. \quad (4.65)$$

This is because the explicit target level of inflation ( $\pi^{cb} = \pi^* - \lambda$ ) deviates even more from the socially optimal target than in the case where target  $\pi^{cb}$  was set such that socially optimal target ( $\pi^*$ ) was achieved. Importance of this result is that if the central bank was successfully insulated from discretionary pressure, the government could assign an explicit inflation target to deliver an outcome, where its policy would be optimal also ex post.

## 4.6 Conclusions

We have discussed several different regimes of monetary policy and compared discretionary policy to the so called precommitment policy. In addition to the conventional cases of discretion and precommitment of the government, we have also analyzed the case where wage setters acted as the leaders of the game. The first important result of the paper is that when the wage setters precommit in an explicit inflation targeting regime, inflation can reach the target level, but it may do so with a substantial loss in output. This loss in output was found to be related on desire of central bank to accommodate as well as labour market distortions. The second important result of the paper is that when the labor markets are sufficiently decentralized, regardless of the weight that the government attaches to output stabilization, the government would always prefer explicit inflation targeting over discretion even if the wage setters had a possibility to precommit. If the wage bargaining was sufficiently centralized ( $N < 3$ ), however, there exists a range of  $\lambda$  values where the government would prefer discretion. Since also the unions would be better off under discretion the whole society might prefer the discretionary regime. This range of  $\lambda$  could typically be assigned to conservative governments, that have only modest incentives to stabilize output.

Finally, when the wage setters responded to the actual policy rule of the government, we found out that the government's policy was not time inconsistent in the usual sense of creating inflationary bias, because the government would find it optimal to reduce inflation. We argued that this may offer an explanation for the decreasing pattern of inflation rates in OECD countries since the mid eighties. We then showed that inflation target for the central bank could be chosen so that the government's policy was credible.

As argued above, the main characteristic of those countries that followed an explicit inflation targeting, such as the U.K, Finland, New Zealand Sweden, Spain and Australia is that prior to the introduction of inflation targeting, these countries went through a fairly difficult phase of labor market reform. In particular, these countries have moved from a system of centralized wage bargaining to a more decentralized one. At the same time there has also been a clear decline in unionization rates in the U.K, New Zealand and Australia. Attempts to decentralize wage bargaining have indeed been a precondition to the adoption of inflation targeting. Less centralized wage setting has also implied that the length of wage contracts have been considerably shortened. It is likely that countries that succeed in their labor market reforms were also able to decrease monopolistic wage competition, thus enabling the inflation targeting regime to yield superior macroeconomic performance when compared with discretion. Our empirical results in Chapter 2 supported this argument.

During the adoption of inflation targeting, 3 of the inflation targeting countries have been governed by left-wing governments and 4 by conservative governments (see Table D.1.) If we interpreted conservative governments as having a small  $\lambda$ , the model gets further support from reality. After an appropriate decentralization of wage bargaining and after the adoption of an inflation targeting regime all inflation targeting countries experienced a shift from right-wing to left-wing or from left-wing to right-wing governments. In none of the countries have inflation targeting regime been questioned so far. Our model predicts that when the labor markets are sufficiently decentralized, regardless of  $\lambda$ , the government prefers the inflation targeting regime.

A question that remains unanswered, but is highly important, is how the inflation targeting regime would work in the EMU. It is clear that the structure of the labour markets differ in those countries that have joined the context of European Monetary Union (EMU). Moreover, in

many of the member countries explicit inflation targeting has not yet been implemented so that the membership does not only imply a fixed exchange rate but also a clear change in the monetary regime, from which many of the countries do not yet have experience. Even if inflation targeting is not the dominant regime in the EMU area, our model predicts substantial difficulties in those countries with centralized wage bargaining. Moreover, because the labor market structure differs and these difficulties are expected, the European Central Bank (ECB) will have to compromise with the monetary policy. Whether this harms the credibility of the ECB at the outset is an open question. Moreover, the transition from an old regime to new one depends crucially on how the private sector reacts to this new regime. The framework given in this Chapter could address these issues after appropriate modifications, but those are beyond the scope of this study.

## 5 Concluding comments

This thesis has studied a new class of political economy models in unionised economies and produced new theoretical insights and empirical results on the importance of the interaction between central bank independence, credibility and wage bargaining structure. Our empirical findings showed that different wage bargaining practices have indeed played a critical role in a successful anti-inflation policy, together with the establishment of an independent central bank and the adoption of inflation targeting. In particular, empirical results also suggested that it matters which form of independence is emphasised when considering the status of the central banks. While higher *political independence* of the central bank reduces inflation, *personnel independence* contributes both to lower unemployment and wage inflation. Typically, empirical studies of the kind, have concentrated on highly aggregated measure of central bank independence. The adoption of inflation targeting, which has basically implied that the central bank has been given almost full instrument independence has been successful according to our empirical findings. It seems that moderate inflation rates have been achieved without costs in terms of output. Some of the empirical evidence, however, showed that the dominance of the price objective, while leading to lower inflation rates, generates negative effects on unemployment. Given, that the importance of the price stability goal in the central bank objective can be closely related to “the degree of conservativeness of the central banker” our results suggest that conservativeness as such is not necessarily desirable. It is most important to establish arrangement for the central banker such that discretionary power of the government on the central bank is limited by legislation, while a flexibility of the monetary policy should be left to the independent monetary authority. Granting political independence for the central bank seems to be the best way to achieve this goal.

With regard to wage bargaining structure, our empirical findings



most strongly showed that facilitating co-operation in wage bargaining is crucial and improves both inflation and unemployment performance. A large difference between coverage and unionization rates, in turn, leads to both higher nominal wage growth and higher unemployment rate. The Calmfors-Driffill hypothesis, which states that the relationship between wage growth and unemployment should be hump-shaped gains some support from the data. We suggested that these results support the need either to reduce statutory arrangements which extend wage contracts to non-union members or the need to move away from the industry level bargaining systems, where the difference between coverage and density rates tend to be the largest. Moreover, securing the credibility of the central bank by granting legal independence for the central bank is not sufficient to guarantee successful inflation stabilization. Structural reforms in the wage bargaining practices are also necessary. In this vein, our results also supported the argument that European unemployment problems are largely structural, to which stabilisation policy cannot successfully influence.

Given these interesting empirical findings, the thesis proceeded by extending the traditional game theoretic models of monetary policy to consider unionised economies. The main motivation was to develop a framework, which could address issues with regard to different wage bargaining structures. Chapter 3, then, developed a model, in which wage setting is monopolistic and structural problems in labour markets are due to a Keynesian type of co-ordination failure in wage bargaining. In this model, we relaxed the conventional representative agent assumption of the standard credibility model and instead considered a situation where wage setters are organised unions whose actions can have a predictable influence on the aggregate economy. In addition to monopolistic unions, the fiscal and monetary authorities are also separate.

This chapter demonstrates that an interaction between the private sector (wage setters) and the policymakers in unionised economies is far more complicated than what has been implicitly assumed in the traditional Barro and Gordon (1983b) type of credibility model. In particular, it was shown that discretionary policy might have favorable effects on overall macroeconomic performance, even if the government's incentives were fully taken into account in the private sector's behaviour. The appointment of a conservative central banker seemed to be detrimental for an economy with partially decentralised wage setting, if the government and the central bank disagreed strongly over the relative importance of the targets. The

last important result was that an individual union's utility could be lower in the game where unions respond to the actual policy rule, compared with the traditional discretionary case.

The model developed in Chapter 3 included separate authorities for fiscal and monetary policy, linked by an instantaneous budget constraint. Chapter 4 then concentrates on monetary policy solely and in particular, analyses an inflation targeting regime in the unionised economy.

The first important result of Chapter 4 was that an inflation targeting regime, when the private sector responds to the actual policy rule of the central bank, may lead to a substantial loss in output. This loss in output is greater the more the central bank is ready to accommodate and the larger the co-ordination failure in wage bargaining. The second important result of the Chapter 4 was that when the labour markets are sufficiently decentralised, regardless of the weight that the government attaches to output stabilisation, the government would always prefer explicit inflation targeting over discretion. If the labour markets were sufficiently centralised, however, there exists a range of preferences where the government would prefer discretion. Since the unions would also be better off under discretion, the whole society might prefer the discretionary regime. This range of output stabilisation parameter could typically be assigned to "conservative" governments or central banks, that has only modest incentives to stabilise output. The sequence of monetary and labour market reforms that have actually taken place, seemed to support this finding. If the inflation target for the central bank was chosen appropriately, it is shown that this inflation target assignment could be made such that the government's policy could be optimal also ex post. Finally, contrary to Svensson (1997), it was shown that the appointment of a weight conservative central banker is welfare improving also in inflation targeting regime.



# Bibliography

- Akhand, H. (1992), 'Policy credibility and inflation as a wage-setting game', *Canadian Journal of Economics* XXV(2), 407–419.
- Alesina, A. (1987), 'Macroeconomic policy in a two-party system as a repeated game', *Quarterly Journal of Economics*.
- Alesina, A. – Summers, L. (1993), 'Central bank independence and macroeconomic performance: Some comparative evidence', *Journal of Money Credit and Banking* 25(2), 151–62.
- Alesina, A. – Tabellini, G. (1987), 'Rules and discretion with noncoordinated monetary and fiscal policies', *Economic Inquiry* XXV, 619–630.
- Alesina, A. – Tabellini, G. (1988), 'Credibility and politics', *European Economic Review* 32(2-3), 542–550.
- Backus, D. – Driffill, J. (1985), 'Inflation and reputation', *American Economic Review* 75(3), 530–537.
- Baltagi, B. (1995), *Econometric Analysis of Panel Data*, Wiley.
- Barro, R. (1986), 'Reputation in a model of monetary policy with incomplete information', *Journal of Monetary Economics* 17, 3–20.
- Barro, R. – Gordon, D. (1983a), 'A positive theory of monetary policy in a natural rate world', *Journal of Political Economy* 91(4), 589–610.
- Barro, R. – Gordon, D. (1983b), 'Rules, discretion and reputation in a model of monetary policy', *Journal of Monetary Economics* (12), 101–121.

- Barro, R. J. (1976), 'Rational expectations and the role of monetary policy', *Journal-of-Monetary-Economics* 2(1), 1–32.
- Basar, T. – Salmon, M. (1990), 'Credibility and the value of information transmission in a model of monetary policy and inflation', *Journal of Economic Dynamics and Control* 14, 97–116.
- Beck, N. – Katz, J. (1995), 'What to do (and not to do) with time-series-cross-section data', *American Political Science Review* 89, 634–648.
- Beetsma, R. M. – Bovenberg, A. (1996), Does monetary unification lead to excessive debt accumulation, mimeo, CEBR and DELTA.
- Bertola, G. – Ichino, A. (1995), 'Crossing the river: A comparative perspective on italian employment dynamics', *Economic Policy* (21), 359–415.
- Blackburn, K. – Christensen, M. (1987), 'Macroeconomic policy games and reputational equilibria in a contracting model', *Ricerche Economiche* (XLI,2), 190–209.
- Blackburn, K. – Christensen, M. (1989), 'Monetary policy and credibility', *Journal of Economic Literature*.
- Blanchard, O. (1986), 'The wage price spiral', *Quarterly Journal of Economics* (101), 543–565.
- Bleaney, M. (1996), 'Central bank independence, wage bargaining structure, and macroeconomic performance in oecd countries', *Oxford Economic Review* 70, 21–38.
- Breusch, T. S. – Pagan, A. R. (1980), 'The lagrange multiplier test and its applications to model specification in econometrics', *Review of Economic Studies* 47, 239–253.
- Briault, C. – Haldane, A. – King, M. (1996), 'Independence and accountability', Bank of England Working Paper, No. 49.
- Bruno, M. – Sachs, J. (1985), *The Economics of World Wide Stagflation*, Oxford, Basil Blackwell.
- Buiter, W. H. (1983), 'Expectations and control theory', *Economie-Appliquee* 36(1), 129–56.

- Bull, C. – Frydman, R. (1983), ‘The derivation and interpretation of the lucas supply function’, *Journal of Money, Credit and Banking* 15(1), 82–95.
- Cagan, P. (1956), The monetary dynamics of hyperinflation, in M. Friedman, ed., ‘Studies in the Quantity Theory of Money’, University of Chicago Press, pp. 25–120.
- Calmfors, L. (1982), ‘Employment policies, wage formation and trade union behavior in a small open economy’, *Scandinavian Journal of Economics* 84(4), 345–373.
- Calmfors, L. – Driffill, J. (1988), ‘Bargaining structure, corporatism and macroeconomic performance’, *Economic Policy* 6, 14–61.
- Calmfors, L. – Horn, H. (1985), ‘Classical unemployment, accommodation policies and the adjustment of real wages’, *Scandinavian Journal of Economics*.
- Calmfors, L. – Horn, H. (1986), ‘Employment policies and centralized wage setting’, *Economica*.
- Calvo, G. (1978), ‘On the time consistency of optimal policy in a monetary economy’, *Econometrica*.
- Calvo, G. (1983), ‘Staggered contracts in a utility-maximizing framework’, *Journal of Monetary Economics* 12, 383–98.
- Cameron, D. R. (1984), Social democracy, corporatism, labour quiescence and the representation of economic interest in advanced capitalist society, in J. H. Goldthorpe, ed., ‘Order and Conflict in Contemporary Capitalism’, New York; Toronto; Delhi, Oxford University Press, pp. 143–78.
- Canzoneri, M. (1985), ‘Monetary policy games and the role of private information’, *American Economic Review* 75(5), 1056–1069.
- Canzoneri, M. – Henderson, D. (1988), ‘Is sovereign policy-making bad’, *Carnegie-Rochester Conference Series on Public Policy* 28, 93–140.
- Cargill, T. F. (1995), ‘The statistical association between central bank independence and inflation’, *Banca-Nazionale-del-Lavoro-Quarterly-Review* 48(193), 159–72.

- Carlin, W. – Soskice, D. (1990), *Macroeconomics and the Wage Bargaining*, Oxford University Press.
- Chari, V. – Christiano, L. – Eichenbaum, M. (1996), ‘Expectation traps and discretion’, National Bureau of Economic Research Working Paper, 5541.
- Cho, I.-K. – Sargent, T. (1996), ‘Learning to be credible’, Presented at the conference to celebrate the Bank of Portugal’s 150th birthday. November.
- Chow, G. (1981), *Econometric Analysis by Control Methods*, New York, Wiley.
- Cohen, D. – Michel, P. (1988), ‘How should control theory be used to calculate time consistent government policy’, *Review of Economic Studies* 55, 263–274.
- Cooper, R. – John, A. (1988), ‘Coordinating coordination failures in keynesian models’, *Quarterly Journal of Economics* CIII(3), 441–463.
- Cottarelli, C. – Giannini, C. (1997), ‘Credibility without rules? monetary frameworks in the post-bretton woods era’, International Monetary Fund, Occasional Paper 154.
- Cripps, M. (1991), ‘Learning rational expectations in a policy game’, *Economic Dynamics and Control* 15, 297–315.
- Crouch, C. (1985), Corporatism in industrial relations: A formal model, in W. Grant, ed., ‘The Political Economy of Corporatism’, St. Martin’s Press, New York, pp. 63–88.
- Cubitt, R. P. (1992), ‘Monetary policy games and private sector precommitment’, *Oxford Economic Papers* 44, 513–530.
- Cukierman, A. (1992), *Central Bank Strategy, Credibility and Independence*, Cambridge, MA, MIT Press.
- Cukierman, A. – Lippi, F. (1998), ‘Central bank independence, centralization of wage bargaining, inflation and unemployment - theory and evidence.’, CEPR ; Discussion paper ; 1847.

- Cukierman, A. – Meltzer, A. (1986), 'Theory of ambiguity, credibility and inflation under discretion and asymmetric information', *Econometrica* 54, 1009–1128.
- Debelle, G. – Fischer, S. (1994), How independent should a central bank be, in J. C. Fuhrer, ed., 'Goals, Guidelines, and Constraints Facing Monetary Policymakers', number 392, Federal Reserve Bank of Boston.
- Deutsch, K. (1963), *Nerves of Government*, Glencoe, Free Press.
- Driffill, E. J. (1987), 'Macroeconomic policy games with incomplete information: Extensions and generalizations', University of Southampton, Mimeo.
- Driffill, J. (1985), 'Macroeconomic policy and trade unions behavior as a repeated game', *Scandinavian Journal of Economics*.
- Easton, D. (1965), *A System Analysis of Political Life*, London, John Wiley.
- Egebo, T. – Englander, A. S. (1992), 'Institutional commitments and policy credibility: A critical survey and empirical evidence from the ERM', *OECD Economic Studies* 0(18), 45–84.
- Eijffinger, S. – Haan, J. D. (1996), 'The political economy of central-bank independence', Princeton University, Department of Economics Working Paper.
- Eijffinger, S. – Schaling, E. (1993), 'Central bank independence in twelve industrialized countries', *BNL Quarterly Review*.
- Elster, J. (1994), 'The impact of constitutions on economic performance', Proceedings of the World Bank's Annual Conference on Development Economics (Washington, World Bank).
- Evans, M. D. (1990), 'Optimal pre-commitment in macro-economic policy: A game theoretic analysis of fiscal policy', *Oxford Economic Papers* (42), 695–714.
- Fair, R. C. (1978), 'A criticism of one class of macroeconomic models with rational expectations', *Journal of Money, Credit and Banking* 10(4), 411–417.



- Faust, J. – Svensson, E. O. (1998), 'Transparency and credibility: Monetary policy with unobservable goals', NBER working paper, No. 6452.
- Fischer, S. (1977), 'Long term contracts rational expectation, and the optimal money supply rule', *Journal of Political Economy* 85, 1919–1926.
- Fischer, S. (1994), Modern central banking, in S. F. F. Capie, G. Goodhart – N. Schnadt, eds, 'The Future of Central Banking', Cambridge, Cambridge University Press.
- Forder, J. (1998), 'The case for an independent european central bank: A reassessment of evidence and sources', *European Journal of Political Economy* 14(1), 53–71.
- Freeman, R. (1988), 'Labour market institutions, constraints and performance', National Bureau of Economic Research Working Paper: 2560, April.
- Friedman, M. (1956), *A Theory of Consumption Function*, Princeton University Press.
- Friedman, M. (1962), *Capitalism and Freedom*, Chicago, London, The University of Chicago Press.
- Friedman, M. (1968), 'The role of monetary policy', *American Economic Review* 58(1), 1–17.
- Friedman, M. (1969), The optimum quantity of money, in M. Friedman, ed., 'The Optimum Quantity of Money and Other Essays', Aldine, Chicago.
- Frydman, R. – Phelps, E. (1983), *Individual Forecasting and Aggregate Outcomes*, London, Cambridge University Press.
- Fuller, W. – Battese, G. (1973), 'Transformations for estimation of linear models with nested error structure', *Journal of the American Statistical association* 68, 626–632.
- Golden, M. (1993), 'The dynamics of trade unionism and national economic performance', *American Political Science Review*.

- Goodhart, C. (1993), Central bank independence, Special Paper 57, LSE Financial Markets Group.
- Grilli, V. – Masciandaro, D. – Tabellini, G. (1991), ‘Political and monetary institutions and public financial policies in the industrial countries’, *Economic Policy* 6(2), 341–92.
- Gylfason, T. – Lindbeck, A. (1986), ‘Endogeneous unions and governments’, *European Economic Review* 30(1), 5–26.
- Haldane, A. G. (1995), Targeting inflation: Introduction, in A. G. Haldane, ed., ‘Targeting Inflation’, Bank of England, pp. 1–12.
- Hansen, B. (1958), *The Economic Theory of Fiscal Policy*, London, Allen and Unwin.
- Harbridge, R. – Honeybone, A. (1996), ‘External legitimacy of unions: Trends in new zealand’, *Journal of Labor Research* 17, 425–444.
- Hasse, R. (1990), *The European Central Bank: Perspectives for a Further Developments at the European Monetary System*, Guetersloh, Bertelsmann.
- Hausman, J. (1978), ‘Specification tests in econometrics’, *Econometrica* 46, 1251–1271.
- Herrendorf, B. – Neumann, M. J. (1997), ‘The political economy of inflation and central bank independence’. unpublished.
- Hughes-Hallett, A. (1986), ‘International policy design and the sustainability of policy bargains’, *Journal of Economic Dynamics and Control* 10, 467–494.
- Iversen, T. (1998), ‘Wage bargaining, hard money and economic performance: Theory and evidence for organized market economies’, *British Journal of Political Science* 28, 31–61.
- Jackman, R. – Layard, R. – Nickell, S. (1991), *Unemployment: Macroeconomic Performance and the Labour Market*, Oxford, Oxford University Press.
- Jensen, H. (1992), Efficient bargaining and accommodation policies, Memo 13, Aarhus Universitet, Economisk Institut.

- Jensen, H. (1992a), 'Time inconsistency problems and commitments of monetary and fiscal policy', *Journal of Economics* (3), 247–266.
- Kilponen, J. – Sannes, L. – Sone, K. (1992), 'Turbulence of the European monetary system -causes and consequences', Kiel Advanced Studies Working Papers, No. 237.
- Kirman, A. P. (1992), 'Whom or what does the representative individual represent', *Journal of Economic Perspectives* 6(2), 117–136.
- Kreps, D. M. – Wilson, R. (1982), 'Reputation and imperfect information', *Journal-of-Economic-Theory* 27, 253–79.
- Kydland, F. – Prescott, E. (1977), 'Rules rather than discretion: The inconsistency of optimal plans', *Journal of Political Economy* 85(3), 473–491.
- Lange, P. (1984), Union, workers and wage regulation, in J. Goldthorpe, ed., 'The Rational Bases of Consent', Oxford, Oxford University Press.
- Lau, S.-H. L. (1996), 'Aggregate pattern of time-dependent adjustment rules: A game theoretic analysis of staggered versus synchronized wage setting', *The Economic Journal* 106, 1645–1658.
- Leiderman, L. – Svensson, L. (1995), Inflation targets: Introduction, in L. Leiderman – L. Svensson, eds, 'Inflation Targets', Centre for Economic Policy Research, pp. 1–18.
- Lindbeck, A. – Snower, D. (1988), *The Insider-Outsider Theory of Employment and Unemployment*, Cambridge, MA, MIT Press.
- Lindbeck, A. – Snower, D. J. (1989), 'Demand and supply side policies and unemployment: Policy implications of the insider-outsider approach', Centre for Economic Policy Research Discussion Paper: 329, August.
- Lucas, R. (1972), 'Expectations and neutrality of money', *Journal of Economic Theory* 4, 103–124.
- Lucas, R. (1973), 'Some international evidence on output-inflation trade-off', *American Economic Review* 63(2), 326–334.

- Lucas, R. (1975), 'An equilibrium model of business cycle', *Journal of Political Economy* 83, 1113–1144.
- Lucas, R. – Rapping, L. (1969), 'Real wages, employment and inflation', *Journal of Political Economy* pp. 721–54.
- Mangano, G. (1998), 'Measuring central bank independence: A tale of subjectivity and of its consequences', *Oxford Economic Papers* 50, 468–492.
- Marcellino, M. – Salmon, M. (1997), 'Robust decision theory and the theoretical irrelevance of the lucas critique-twenty years on', European University Institute. unpublished.
- McCallum, B. (1995), 'Two fallacies concerning central bank independence', *American Economic Review Papers and Proceedings* 85, 207–211.
- McCallum, B. (1996), 'Inflation targeting in canada new zealand, sweden, the united kingdom, and in general', NBER Working Paper Series No. 5579.
- Miller, M. – Salmon, M. (1985), 'Dynamic games and time inconsistency of optimal policy in open economies', *Economic Journal* 95(0), 124–135. Supplement.
- Mishkin, F. S. – Posen, A. S. (1997), 'Inflation targeting: Lessons from four countries', *Federal-Reserve-Bank-of-New-York-Economic-Policy-Review* 3(3), 9–110.
- Muth, J. (1961), 'Rational expectations and the theory of price movements', *Econometrica* 29, 315–335.
- Nerlove, M. (1958), *The Dynamics of Supply: Estimation of Farmers' Response to Price*, Baltimore, John Hopkins University Press.
- OECD (1994), *Collective Bargaining: Levels and Coverage*, Employment Outlook, OECD, chapter 5, pp. 167–195.
- OECD (1997), *Economic Performance and the Structure of Collective Bargaining*, Employment Outlook, OECD, chapter 3, pp. 63–92.

- Olson, M. (1965), *The Logic of Collective Action*, Cambridge, Harvard University Press.
- Park, R. (1967), 'Efficient estimation of a system of regression equations when disturbances are both serially and contemporaneously correlated', *Journal of the American Statistical Association* 62, 500–509.
- Parkin, M. (1987), Domestic monetary institutions and deficits, in J. Buchanan – C. Rowley – R. Tollison, eds, 'Deficits', New York, Basil Blackwell.
- Persson, T. – Tabellini, G. (1990), *Macroeconomic Policy, Credibility and Politics*, Paris, Harvard Academic Publishers.
- Persson, T. – Tabellini, G. (1993), 'Designing institutions for monetary stability', *Carnegie-Rochester Conference Series on Public Policy* 39, 53–84.
- Persson, T. – Tabellini, G. (1997), 'Political economics and macroeconomic policy', NBER Working Paper Series No. 6329.
- Petit, M. (1991), *Control Theory and Dynamic Games in Economic Policy Analysis*, Cambridge, Press Syndicate of the University of Cambridge.
- Phelps, E. (1967), 'Phillips curves, expectations of inflation and optimal unemployment over time', *Economica*.
- Phelps, E. (1970), Introduction, in E. Phelps, ed., 'Microeconomic Foundations of Employment and Inflation Theory', New York, Norton, pp. 1–23.
- Phelps, E. (1983), Rational expectations and inflation stabilization, in R. Frydman – E. Phelps, eds, 'Individual Forecasting and Aggregate Outcomes', Cambridge University Press, London, pp. 31–45.
- Pohjola, M. (1987), 'Profit-sharing, collective bargaining and employment', *Journal-of-Institutional-and-Theoretical-Economics* 143(2), 334–42.

- Pollard, P. S. (1993), 'Central bank independence and economic performance', *Federal Reserve Bank of St.-Louis Review* 75(4), 21–36.
- Posen, A. S. (1993), Why central bank independence does not cause low inflation: There is no institutional fix for politics, in R. O'Brien, ed., 'Finance and the International Economy', Oxford University Press, Oxford.
- Rasmussen, B. S. (1994), 'Wage formation, the structure of labour taxation and welfare', Aarhus Institute of Economics Memo.
- Roberts, J. M. (1995), 'New keynesian economics and the phillips curve', *Journal-of-Money,-Credit,-and-Banking* 27(4), 975–84.
- Rogoff, K. (1985), 'The optimal degree of commitment to an intermediate monetary target', *The Quarterly Journal of Economics* 100(4), 1169–1190.
- Sargent, T. (1996), 'Expectations and the nonneutrality of lucas', unpublished.
- Sargent, T. – Wallace, N. (1975), 'Rational expectations, the optimal monetary instrument, and the optimal money supply', *Journal of Political Economy* (83), 241–254.
- Sargent, T. – Wallace, N. (1981), 'Some unpleasant monetaristic arithmetic', *Federal Reserve Bank of Minneapolis Quarterly Review* pp. 1–17.
- Scarpetta, S. (1996), 'Assessing the role of labor market policies and institutional settings on unemployment: A cross-country study', OECD, Economic Studies, No. 26, pp. 45-97.
- Skott, P. (1997), 'The stagflationary consequences of prudent monetary policy in a unionized economy', *Oxford Economic Papers* 49, 609–622.
- Soskice, D. (1990), 'Wage determination: The changing role of institutions in advanced industrial countries', *Oxford Review of Economic Policy* 6, 36–61.

- Svensson, L. E. (1997), 'Optimal inflation targets, conservative central banks and linear inflation contracts', *American Economic Review* 87, 98–114.
- Tabellini, G. (1985), 'Endogenous monetary and fiscal policies under alternative institutional settings - a game theoretic analysis', University of California Working Paper No. 368.
- Tabellini, G. (1987), 'Central bank reputation and monetization of deficits: The 1981 Italian monetary reform', *Economic Inquiry* 25(2), 185–200.
- Taylor, J. (1979), 'Staggered wage setting in a macro model', *American Economic Review* 69, 108–13.
- Taylor, J. (1980), 'Aggregate dynamics and staggered contracts', *Journal of Political Economy* 88, 1–23.
- Tinbergen, J. (1952), *On the Theory of Economic Policy*, Amsterdam, North-Holland.
- Tinbergen, J. (1954), *Centralization and Decentralization in Economic Policy*, Amsterdam, North-Holland.
- Traxler, F. (1994), 'Collective bargaining: Levels and coverage', University of Vienna, July 1994, mimeo.
- Velasco, A. – Guzzo, V. (1998), 'The case for a populist central banker', NBER ; working paper ; 6802.
- Vickers, J. (1986), 'Signalling in a model of monetary policy with incomplete information', *Oxford-Economic-Papers* 38(3), 443–55.
- Walsh, C. (1995), 'Optimal contracts for central bankers', *American Economic Review* 85(1), 150–167.
- White, H. (1980), 'A heteroskedasticity-consistent covariance matrix estimator and a direct test for heteroskedasticity', *Econometrica* 48(4), 817–38.

# Appendix A

## Design of empirical model in Chapter 2

### A.1 Setup

This appendix discusses estimation methods used in Chapter 2 and various problems associated with the estimation and inference of our data<sup>1</sup>. We also discuss the traditional specification tests of time-series-cross-section models and the problems associated to application of these tests to our data. To begin with, consider the following one-way-(static) error component model

$$\begin{aligned} Y_{it} &= \alpha + X'_{it}\beta + u_{it}, \quad i = 1, \dots, N, t = 1, \dots, T & (A.1) \\ u_{it} &= \mu_i + v_{it} \\ v_{it} &= N(0, \Omega). \end{aligned}$$

$\mu_i$  denotes unobservable individual effects and  $v_{it}$  is a stochastic disturbance term with  $\Omega$  as its variance-covariance matrix.  $y_{it}$  is the  $i$ th observation of the dependent variable and  $X_{it}$  is the  $it$ th observation on the  $k$ th explanatory time-variant variable. In our data set  $i$  denotes country and  $t$  denotes time. In the single equation estimation  $y$  can be inflation, nominal wage growth or unemployment. Including lagged dependent variable among the regressors results the so called dynamic panel model and will be discussed in the context of serially correlated errors.

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<sup>1</sup>This section is largely based on Baltagi (1995).



The term  $u_{it}$  can be written in vector form as

$$u = Z_\mu + v \quad (\text{A.2})$$

so that the whole equation can be written conveniently in vector form as

$$y = \alpha \iota_{NT} + XB + Z_\mu + v. \quad (\text{A.3})$$

$y$  is  $NT \times 1$ ,  $X$  is  $NT \times k$ ,  $Z_\mu$  is  $I_N \oplus \iota_T$  matrix of dummies to estimate fixed effects.  $Z_\mu$  is a matrix of individual dummies and has a dimension  $NT \times T$ .  $\iota_T$  is a vector of ones of dimension  $T$  and  $I_N$  is an identity matrix of dimension  $N$ .  $\oplus$  denotes Kronecker product.  $X$  is  $NT + k$  matrix of economic variables. They are assumed to be stationary and independent on stochastic disturbances  $v$ .  $v$  has a dimension  $NT \times 1$  and  $\beta$  is  $k \times 1$  matrix of common coefficients across panels. We therefore make a critical assumption that the regressors has the same coefficient across countries.

## A.2 Transformations

Before making assumptions necessary for estimation, consider the following representation of the general model

$$y_{it} = \alpha + x_{it}\beta + z_{1,i}\lambda_1 + z_{2,i(t)}\lambda_2 + v_{it} \quad (\text{A.4})$$

where we have decomposed  $z_{i(t)}$  further into those institutional features which are truly time-invariant ( $z_{1,i}$ ) across all cross-sections and to those which are subject to some erratic changes ( $z_{2,i(t)}$ ) across all cross-sections. For completeness, assume now that  $v_{it}$  may comprise some non-modelled fixed effects, such that

$$v_{it} = \mu_i + \epsilon_{it}. \quad (\text{A.5})$$

$v_{it}$  could be further decomposed into  $v_{it} = \mu_i + \gamma_t + \epsilon_{it}$ , where  $\gamma_t$  would be time effect same to all cross-sections. For simplicity we consider only the case where  $v_{it}$  does not include these time effects. Moreover, our data is not a typical labour panel where  $N$  is large and  $T$  is small. In our data  $N$  to  $T$  ratio is close to 1,  $T$  being on average 23 and  $N = 18$ . This has some important consequences for the usage of FGLS method. Another important feature is that we are in particularly interested

in modelling institutional effects, so that we include “fixed effects” among the regressors. This restricts the usage of certain estimation techniques, as will be clarified subsequently.

Let us now consider different transformations that are used when estimating time-series-cross-section models (TSCS).

The so-called **between** transformation (averaging over time) is written as

$$\bar{y}_i = \alpha + \bar{x}_i\beta + \bar{z}_{1,i}\lambda_1 + z_{2,i}\lambda_2 + \mu_i + \bar{\epsilon}_i. \quad (\text{A.6})$$

The so-called **within** transformation is written as

$$(y_{it} - \bar{y}_i) = (x_{it} - \bar{x}_i)\beta + (z_{i(t)} - \bar{z}_i) \lambda_2 + (\epsilon_{it} - \bar{\epsilon}_t). \quad (\text{A.7})$$

First, notice that the between transformation is able to give estimates of  $\lambda_2$  and  $\lambda_1$  as well as  $\mu_i$ , but in order to do so, it must assume that non-modelled fixed effects  $\mu_i$  are uncorrelated with regressors. Within estimation (*fixed effects model*), on the other hand, fails to estimate  $\lambda_1$ , i.e. those truly time-invariant factors if they have been included into the model without transformation and provides estimate of  $\lambda_2$  solely i.e. of those factors which are subject to erratic changes. However, if certain individual characteristics change over time only within a subset of individuals (such as central bank independence), the  $\lambda_2$  is estimated only from that subset. If we then have hypothesised that this individual characteristics should have an (fixed) effect on average level of dependent variable, fixed effects model is not able to capture this effect.

### A.3 Random-effects model

There are often too many parameters to be estimated in the fixed effects model and the loss of degrees of freedom can be avoided if  $\mu_i$  (non-modelled fixed effects) can be assumed random. The so called random effects model assumes that

$$\mu_i \sim IID(0, \sigma_\mu^2) \quad (\text{A.8})$$

$$v_{it} \sim IID(0, \sigma_v^2) \quad (\text{A.9})$$

and that  $\mu_i$  are independent of  $v_{it}$ . A critical assumption of the random effect model is that

$$E(\mu_{it}/x_{it}) = 0 \quad (\text{A.10})$$

i.e. that regressors are independent from the non-modelled random effects. Traditionally, Hausman specification test has been used to test this assumption.

Let us now consider the estimation of variance-covariance matrix. In the general formulae, the variance covariance matrix  $\Omega$  can be computed from (A.2) as

$$\Omega = E(uu') = Z_\mu E(uu')Z_\mu + E(vv') = \sigma_\mu^2(I_N \otimes J_T) + \sigma_v^2(I_N \otimes J_T). \quad (\text{A.11})$$

$I_N$  is identity matrix of dimension  $N$  and  $J_T$  is a matrix of ones dimension  $T$ . This formula implies a homoskedastic variance for all  $i$  and  $t$  and serial correlation is allowed over time only between the disturbances of the same individual. That is,

$$\text{cov}(u_{it}, u_{js}) = \sigma_\mu^2 + \sigma_v^2, \text{ for } i = j, t = s \quad (\text{A.12})$$

$$\text{cov}(u_{it}, u_{js}) = \sigma_\mu^2 \text{ for } i = j, t \neq s \quad (\text{A.13})$$

and zero otherwise. This also means that the correlation coefficient between  $u_{it}$  and  $u_{js}$  is

$$\rho = 1, \text{ for } i = j, t = s \quad (\text{A.14})$$

$$= \frac{\sigma_u^2}{\sigma_\mu^2 + \sigma_v^2}, \text{ for } i = j, t \neq s. \quad (\text{A.15})$$

Random effects model can be estimated with GLS as a matrix weighted average of the estimates produced by the between and within estimators. When applied to general formula in (A.3) it can be shown that

$$\hat{\beta}_{GLS} = W_1 \hat{\beta}_{within} + W_2 \hat{\beta}_{between} \quad (\text{A.16})$$

where weights  $W_i$ ,  $i = 1, 2$  correspond to the inverse of its corresponding variance. In particular, the random effects estimator turns out to be

equivalent with estimation of transformation<sup>2</sup>

$$(y_{it} - \theta \bar{y}_i) = (1 - \theta) \alpha + (x_{it} - \theta \bar{x}_i) \beta + (1 - \theta) z_1 \lambda_1 \quad (\text{A.17})$$

$$+ (z_{i(t)} - \theta \bar{z}_i) \lambda_2 + (\epsilon_{it} - \theta \bar{\epsilon}_i)$$

with OLS. A parameter  $\theta$  is a function of  $\sigma_v^2$  and  $\sigma_\mu^2$ , such that

$$\theta = \frac{\sigma_1 - \sigma_v}{\sigma_1} \quad (\text{A.18})$$

where  $\sigma_1 = \sqrt{T\sigma_\mu^2 + \sigma_v^2}$ . It is now immediately clear that if  $\sigma_\mu^2 = 0$ , then  $\hat{\beta}_{GLS}$  reduces to  $\hat{\beta}_{OLS}$ , i.e. is equivalent of estimating non-transformed equation (A.4). If  $T \rightarrow \infty$ , then  $\hat{\beta}_{GLS}$  tends to  $\hat{\beta}_{within}$ . If  $\frac{\sigma_v^2}{\sigma_1^2} \rightarrow \infty$ , then  $\hat{\beta}_{GLS}$  tends to  $\hat{\beta}_{between}$ . In other words, the within estimator ignores the between variation and the between estimator ignores the within variation. OLS estimator, instead, gives equal weight to within and between variations. Same applies to  $\hat{\lambda}_{1,2}$ , but notice that when  $T \rightarrow \infty$  and  $N$  remains fixed, estimate for  $\lambda_1$  cannot be obtained.

Before turning to estimation and inference itself let us have a closer look at equation (A.17). First notice that the random effects model can yield estimates of  $\lambda_1$  and  $\lambda_2$  as well as  $\beta$ . However, interpretation of the parameter of interest,  $\lambda_1$ , is not straightforward. Taking partial derivatives, we notice that

$$\frac{\partial (y_{it} - \theta \bar{y}_i)}{\partial z_1} = (1 - \theta) \lambda_1 \quad (\text{A.19})$$

$$\frac{\partial (y_{it} - \theta \bar{y}_i)}{\partial (z_{i(t)} - \theta \bar{z}_i)} = \lambda_2. \quad (\text{A.20})$$

This implies that the coefficient obtained to those individual effects, which are truly time invariant comprises of parameter of interest  $\lambda_1$  as well as variance ratio  $\frac{\sigma_1 - \sigma_v}{\sigma_1}$ . However, it is possible to recover  $\lambda_1$  simply by multiplying estimated coefficient by the estimate of  $\frac{1}{1 - \theta}$ . Importance of (A.19) is that the coefficients obtained from different transformations are not directly comparable. This induces some complications to direct interpretation of the Hausman specification test, when the transformations are derived from the model in (A.4). We will return to this issue, after discussing briefly feasible estimators of the variance-covariance matrix  $\Omega$ .

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<sup>2</sup>The reason to estimate transformation is that this transformation inverts a matrix of dimension  $(K + 1)$ , while without transformation we had to invert a covariance matrix of dimension  $NT \times NT$ .

## A.4 Estimation of the variance-covariance matrix

Estimators for the variance components  $\sigma_v^2$  and  $\sigma_1^2$  can be obtained from spectral decomposition of  $\Omega$  and it can be shown that

$$\hat{\sigma}_1^2 = T \sum_{i=1}^N \bar{u}_i^2 / N \quad (\text{A.21})$$

$$\hat{\sigma}_v^2 = \frac{\sum_{i=1}^N \sum_{t=1}^T (u_{it} - \bar{u}_i)^2}{N(T-1)} \quad (\text{A.22})$$

are the best quadratic unbiased (BQU) estimators, when disturbances are homoskedastic and independent. Since true disturbances  $u_{it}$  are not known (A.21) and (A.22) are not feasible. Residuals  $u_{it}$  can be obtained for by substituting OLS residuals  $\hat{u}_{OLS}$  to  $u_{it}$  as suggested by Wallace and Hussain (1969)<sup>3</sup>. These OLS residuals are obtained by estimating between transformation (A.6) by OLS and then calculating  $\theta$  by using formulae (A.21) and (A.22).

## A.5 Heteroskedasticity and panel correlation

So far, we have assumed that the error term fulfils classical properties of homoskedasticity and independence. Further complication arises when the errors exhibit heteroskedasticity and are correlated. As shown by Beck and Katz (1995), Park's (1967) method for correcting heteroskedasticity and different forms of correlation cannot be used unless  $T$  is at least as big as  $N$  and even when  $T$  to  $N$  ratio is close to one, Park's method yield overconfident standard errors of estimated parameters. This yields invalid inference because null hypothesis is rejected too often.

In more general, TSCS models can be difficult to estimate because the error processes in these models can be very complicated. Different assumptions about this error process lead to different preferred methods of estimation. OLS is optimal if the errors are assumed to fulfil conventional properties of homoskedasticity and independence. In many practical estimation situations, however, classical properties of the errors are in doubt.

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<sup>3</sup>For other possibilities see for instance Baltagi (1995).

Independence assumption can be violated from two distinct reasons. First, it is possible that the errors of a particular unit exhibit serial correlation. Second, the errors of one unit may be correlated with the other unit contemporaneously or even with some lag. This is likely to be the case, when the cross-sections are interacting entities, such as countries. Moreover, due to the critical assumption of common coefficient across cross-sections, it is likely that TSCS models exhibit panel heteroskedasticity, implying that variance of the errors is not constant across individuals.

In such situations OLS estimators, at least in large samples, are no more optimal. Moreover, when the errors exhibit heteroskedasticity and are correlated, statistical inference based on the estimated variance-covariance matrix from OLS methods can be seriously flawed, since heteroskedasticity yields standard errors of these estimates to be biased, unless one computes robust standard errors correcting for the possible presence of heteroskedasticity.

In order to attain correct inference, Park (1967) provided method for correcting panel heteroskedasticity and contemporaneous correlation, as well as for cross-sectional serial correlation. This widely applied method, however, yields overconfident standard errors in typical TSCS models, where  $T$  to  $N$  ratio is relatively small. As an example, let us generalise the homoskedastic error component model to the case where  $\mu \sim (0, \Sigma_\mu)$  for  $i = 1, \dots, N$ , but  $v_{it} \sim IID(0, \sigma_v^2)$ . Then, we can write

$$\Omega_v = E(uu') = Z_\mu \Sigma_\mu Z_\mu' + \sigma_v^2 I_{NT} \quad (\text{A.23})$$

where  $\Sigma_\mu = \text{diag}(w_i^2)$  is a diagonal matrix of dimension  $N \times N$ . and  $v \sim (0, \sigma_v^2 I_{NT})$ . Applying Fuller-Battese (1974) transformation it can be shown that the transformed model becomes

$$\begin{aligned} (y_{it} - \theta_i \bar{y}_i) &= (1 - \theta_i) \alpha + (x_{it} - \theta_i \bar{x}_i) \beta + (1 - \theta_i) z_{1t} \lambda_1 \\ &+ (z_{i(t)} - \theta_i \bar{z}_i) \lambda_2 + (\epsilon_{it} - \theta_i \bar{\epsilon}_i) \end{aligned} \quad (\text{A.24})$$

where

$$\theta_i = 1 - \left(\frac{\sigma_v}{\tau_i}\right) \text{ for } i = 1, \dots, N \quad (\text{A.25})$$

$$\tau_i = Tw_i + \sigma_v^2. \quad (\text{A.26})$$

Applying OLS to transformed equation (A.24), we can again estimate  $\lambda_1$  and  $\lambda_2$  and  $\beta$ .

Moreover, feasible GLS requires estimates of  $\sigma_v^2$  and  $w_i$ . Since

$$\text{var}(u_{it}) = E(u_{it}^2) = w_i^2 + \sigma_v^2 = \sigma_i^2 \text{ for } i = 1, \dots, N \quad (\text{A.27})$$

one can estimate

$$\hat{\sigma}_i^2 = \frac{\sum_{t=1}^T (\hat{u}_{it} - \bar{\hat{u}}_i)^2}{T-1} \text{ for } i = 1, \dots, N \quad (\text{A.28})$$

by using OLS residuals. Then, we can obtain

$$\hat{w}_i^2 = \hat{\sigma}_i^2 - \hat{\sigma}_v^2.$$

In the above equation  $\hat{\sigma}_v^2$  has been estimated consistently from within residuals such that

$$\hat{\sigma}_v^2 = \frac{\sum_{i=1}^N \sum_{t=1}^T (\hat{u}_{it} - \bar{\hat{u}}_i)^2}{N(T-1)}. \quad (\text{A.29})$$

It is now immediately clear that this procedure requires large  $T$  and preferably small  $N$  ( $T \gg N$ ). In particular, consistency of the variance components requires that  $T \rightarrow \infty$  and that  $N$  is finite. Another problem is that the estimated variance component  $\hat{w}_i^2$  maybe negative. In practical estimation situation, authors suggest replacing a negative variance estimates by zero.

In small samples, correction for degrees of freedom in estimating  $\sigma_i^2$  may be important and may affect the estimates of the resulting feasible GLS regression coefficients. As shown by Beck and Katz (1995) the problem is even more serious, when  $T$  is close to  $N$  and errors are assumed to be correlated. In the presence of contemporaneous correlation, we need to estimate  $N \times (N+1)/2$  contemporaneous covariances with the total number of observations  $NT$ . A number of observations for each contemporaneous correlation to be estimated ( $\kappa$ ) is then

$$\kappa = \frac{NT}{N \times (N+1)/2} = 2 \frac{T}{N+1}. \quad (\text{A.30})$$

If  $T$  is equal to  $N$ , we would have an average *only 2 observation to estimate the contemporaneous covariances*. From (A.30) it is also clear that  $N$  has to be finite and preferably  $T$  has to be large. This is not the case in our data. On average in our data set  $T = 23$  and  $N = 18$ , so that  $\kappa$  is still very close to 2. Then it is clear that FGLS yields very

inaccurate estimates of the true covariance. Beck and Katz (1995) show by Monte Carlo simulations that FGLS standard errors are massively overconfident when  $T$  to  $N$  ratio is small. This leads invalid inference since null hypothesis is rejected too often. Beck and Katz (1995) then provide an alternative method, which reconstructs  $\Omega$  matrix from OLS residuals by using repeated observations of contemporaneous correlations across time. This procedure is similar to that presented in White (1980), difference being that Beck and Katz (1995) method uses explicitly the panel structure of the data.

One of the disadvantages of OLS estimation method in the presence of non-spherical errors is that parameter estimates are no more efficient in large samples. In particular, this is the case, when the contemporaneous correlation is severe. In the finite samples, it has been suggested that OLS parameter estimates may still perform superior with respect to GLS due to the inaccuracy of estimated variance-covariance matrix and need to invert possibly nearly singular variance covariance matrix. A clear advantage of OLS with panel corrected standard errors is that the overconfidence of the standard errors is removed. Since our data does not show very severe contemporaneous correlation and is clearly a small sample, we follow Beck and Katz (1995) suggestion and estimate the model with OLS and panel corrected standard errors.

## A.6 Serial correlation

In many circumstances, dependent variable exhibits a significant degree of persistence, resulting serially correlated errors in static TSCS model. In our data, inflation, nominal wage growth and unemployment are all such variables. There are two natural ways to remove serial correlation of the errors. First, we may remove serially correlation by following methods provided by Park(1967) or Beck and Katz (1995) or by including a lagged dependent variable into the model.

Inclusion of lagged dependent variable into the model, at first hand, seems the most straightforward way to solve a problem of serial correlation. However, inclusion of lagged dependent variable among the regressors results possibly high collinearity between the lagged dependent variable and individual effects that are highly correlated with the dependent variable. This is simply because individual specific effects



do change only marginally over time or not at all. High collinearity then results to the problem of interpretation of coefficients as well as yields often too high standard errors. We may then accept null hypothesis of zero coefficients too often. Second, inclusion of lagged dependent variable in the presence of non-modelled fixed effect result biased estimates due to the violation of assumption that  $E(\mu_i/x_{it}) = 0$ . To see this, consider the following dynamic panel model

$$y_{it} = \delta y_{it-1} + x_{it}\beta + z_{1,i(t)}\lambda_1 + z_{2,i}\lambda_2 + u_{it} \quad (\text{A.31})$$

where  $Z_i$  has been decomposed into time-invariant variables and into those which may change over time.  $x_{it}$  denote again economic variable. Assume then that  $u_{it}$  follow a one-way error component model

$$u_{it} = \mu_i + v_{it}. \quad (\text{A.32})$$

Assuming that the true model is (A.31), the presence of lagged dependent variable yields the biased and inconsistent OLS estimator for  $\delta$  in the conventional OLS estimation. Although, the within transformation wipes out the non-modelled fixed effects  $\mu_i$ , the within transformation,  $(y_{it-1} - \bar{y}_{i,-1})$  will still be correlated with  $v_{it} - \bar{v}_t$ . This is because  $y_{it-1}$  is correlated with  $\bar{v}_i$  by construction. The bias of the within-estimator is of  $O(T^{-1})$  and its degree of consistency depends upon  $T$ . The same problem applies to the random effects GLS estimator. When individual effects are included into regressors, such that error term is whitened, this problem has been removed. It is therefore important to test for significance of the individual effects of the errors and make sure that individual effects have been successfully removed from the error component  $u_{it}$ . However, as already argued, this will induce possibly high collinearity among  $(y_{it-1} - \bar{y}_{i,-1})$  and modelled individual effects. To control for seriousness of collinearity problem, one can estimate the model with autocorrelation correction and compare the results.

An alternative transformation that wipes out the individual effects but does not create the problem of correlation of  $y_{it-1}$  and error components is to first difference the model and then use  $\Delta y_{it-2}$  or  $y_{it-2}$  as an instrument for  $\Delta y_{it-1}$ . These instruments will not be correlated with  $\Delta v_{it} = v_{it} - v_{i,t-1}$ . The problem with this procedure, however, is that it wipes out the modelled time invariant individual effects and therefore, is not applicable to our data.

## A.7 Specification testing

### A.7.1 Hausman misspecification test

A critical assumption in the random effect model is that

$$E(u_{it}/X_{it}) = 0. \quad (\text{A.33})$$

This is important, given that the disturbance contain individual non-modelled effects  $\mu_i$  which might be correlated with explanatory variables. If assumption (A.33) does not hold, regression coefficients from (A.17) become biased and inconsistent. Hausman test compares coefficients obtained from random effects model to those obtained from within regression, where the null hypothesis is that those coefficients do not differ significantly. Hausman test<sup>4</sup> can be written

$$H = \hat{q}' (\text{var}(\hat{q}))^{-1} \hat{q}, \quad (\text{A.34})$$

where

$$\begin{aligned} \hat{q} &= \hat{\beta}_{GLS} - \hat{\beta}_{within} \\ \text{var}(\hat{q}) &= \sigma_v^2 (X'QX)^{-1} - \sigma_v^2 (X'\Omega X)^{-1} \\ H &\stackrel{H_0}{\sim} \chi_k^2 \end{aligned}$$

$k$  is number of regressors and  $Q$  is transformation matrix which obtains deviations of mean of  $X$ . Unknown variance-covariance matrix  $\Omega$  is replaced by its consistent estimator  $\hat{\Omega}$  of FGLS.

However, there are two problems associated with the usage of this test with our data. First, estimates of slope coefficients from the random effects model and within regression are not directly comparable, as outlined above. When individual specific effects (time invariant) has been included among regression, within estimation fails to provide estimates of  $\lambda_1$ . In such a case, we can successfully compare only  $\beta$ s and  $\lambda_2$ . A second problem is that the Hausman specification test rely on independence and constant variance assumptions. If either heteroskedasticity or independence assumptions are violated, the traditional Within and GLS estimators are not valid and the corresponding Hausman test statistic is inappropriate. Moreover, if FGLS has been applied to estimate a variance-covariance matrix in the presence of contemporaneous correlation and heteroskedasticity, Hausman specification test rejects the null too often.

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<sup>4</sup>Hausman (1978).

### A.7.2 Breusch and Pagan test for random effects

Breusch and Pagan test for random effects is an application of Lagrange Multiplier test to test individual effects in error component model, i.e. to test whether  $\mu_i$  are different from zero<sup>5</sup>. Under the null hypothesis of no individual effects this test statistics is  $\chi^2(1)$  distributed and it requires only OLS residuals. The general formulae for balanced data is

$$BP_{LM} = \frac{NT}{2(T-1)} \left( 1 - \frac{\sum_{i=1}^N (\sum_{t=1}^T v_{it})^2}{\sum_i \sum_t v_{it}^2} \right)^2 \quad (\text{A.35})$$

$$BP_{LM} \stackrel{H_0}{\sim} \chi^2(1) \quad (\text{A.36})$$

where  $v_{it}$  are replaced by the estimated OLS counterparts. This tests can be applied to one-way-error component model, but application to two-way-model is straightforward and is given for instance in Baltagi (1995). A problem with Breusch and Pagan test is that it is two sided test which tests against an alternative of  $\sigma_\mu^2 \neq 0$ . Another problem is that when errors exhibit serial correlation, the Breusch Pagan test is inappropriate. One therefore has to remove serial correlation before this test statistics can be applied. Baltagi (1995) provides various alternative LM tests for testing the fixed effects and time effects. Tests  $LM_\mu$ ,  $LM_\lambda$  and  $LM_{\mu,\rho}$  refer to these tests in the main text and correspond to tests statistics given in (4.38), (4.42) and (5.36) in Baltagi (1995). Derivation and discussion of these test statics is given in Baltagi (1995) and we will not repeat the derivation here.

### A.7.3 Test for serial correlation

Appropriate test statistics to test against serial correlation in TSCS models, depends upon characteristics of the estimated model's errors, but different forms of LM tests can be applied, as suggested by Baltagi (1995). In the presence of fixed effects one can use Within residuals to construct a test against first order serial correlation as follows

$$BL_{F2} = (NT^2/(T-1))(\hat{v}'v_{-1}/\hat{v}'v) \quad (\text{A.37})$$

$$BL \stackrel{H_0}{\sim} \chi^2(1)$$

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<sup>5</sup>Breusch and Pagan (1980).

where  $\hat{v}$  are the usual within residuals from (A.7). In a case of an AR(1) model and random effects, the null hypothesis is that  $\rho = 0$  and an alternative is that  $\rho$  is different from zero or that  $\rho > 0$ . One-sided alternative corresponding to test an alternative hypothesis that  $\rho > 0$  is just

$$BL_{F1} = \sqrt{(NT^2/(T-1))}(\hat{v}'v_{-1}/\hat{v}'v) \quad (\text{A.38})$$

$$BL \stackrel{H_0}{\approx} N(0, 1).$$

In the case of random effects, the test statistics is more complicated, because one has to apply GLS method to estimate variance-covariance matrix under the null hypothesis. Complete derivation of this test is given in Baltagi (1995). We give here only brief idea of the derivation.

The variance covariance matrix under alternative is

$$\Omega_1 = \sigma_\mu^2(I_N \otimes J_T) + \sigma_v^2(I_N \otimes V_\rho) \quad (\text{A.39})$$

where  $V_\rho$  is a variance covariance matrix of AR(1) process defined as

$$v_{it} = \rho v_{it-1} + \epsilon_{it}. \quad (\text{A.40})$$

LM test can be derived from the maximum likelihood function

$$L(\delta, \Lambda_r) = \text{constant} - \frac{1}{2} \log(\Omega_1) - \frac{1}{2} u' \Omega_1^{-1} u \quad (\text{A.41})$$

$$\Lambda_r = \Lambda(\rho, \sigma_\mu^2, \sigma_\epsilon^2). \quad (\text{A.42})$$

In order to construct Lagrange Multiplier test one needs the first derivative of the maximum likelihood function, as well as information matrix. Taking the first derivative with respect  $\Lambda_r$  yields

$$\frac{\partial L}{\partial \Lambda_r} = -\frac{1}{2} \text{tr}(\Omega_1^{-1} \left( \frac{\partial \Omega_1}{\partial \Lambda_r} \right)) + \frac{1}{2} (u' \Omega_1^{-1} \frac{\partial \Omega_1}{\partial \Lambda_r} \Omega_1^{-1} u). \quad (\text{A.43})$$

Evaluating derivatives  $\frac{\partial \Omega_1}{\partial \Lambda_r}$  at  $\rho = 0$  and substituting them into (A.43) gives after some manipulations

$$D_\rho = \frac{\partial L}{\partial \rho|_{\rho=0}} = N(T-1) \frac{\sigma_\mu^2}{T\sigma_\mu^2 + \sigma_\epsilon^2} + \frac{\sigma_\epsilon^2}{2} u' F u \quad (\text{A.44})$$

where

$$F = I_N \otimes [(\bar{J}_T/\sigma_1^2 + E_T/\sigma_\epsilon^2) \frac{\partial V_\rho}{\partial \rho|_{\rho=0}} (\bar{J}_T/\sigma_1^2 + E_T/\sigma_\epsilon^2)] \quad (\text{A.45})$$

where  $\bar{J}_T = \iota_T \iota_T' / T$ ,  $\iota_T$  is a matrix of ones,  $E_T = I_T - \bar{J}_T$  and  $\sigma_1^2 = T\sigma_\mu^2 + \sigma_\epsilon^2$ .

Next step it to use  $D_\rho$  and to construct an information matrix  $J = E \left[ -\frac{\partial^2 L}{\partial \Lambda_r \partial \Lambda_r'} \right]$ <sup>6</sup>.  $LM$  test takes then a form

$$LM'_\rho = D' J^{-1} D \quad (\text{A.46})$$

$$LM'_\rho \stackrel{H_0}{\underset{Asy}{\rightsquigarrow}} \chi^2(1).$$

In practice, residuals  $u$  are replaced by the estimated maximum likelihood residuals under the null hypothesis. It can be shown that (A.46) can also be used to test whether residuals are  $MA(1)$ , such as

$$v_{it} = \epsilon_{it} + \lambda \epsilon_{it-1}.$$

In this case, the null hypothesis  $\lambda = 0$  is tested against an alternative  $\lambda \neq 0$ . This test statistic is therefore invariant to form of serial correlation. One-sided analogy to test  $\rho > 0$  or correspondingly to test whether  $\lambda > 0$  when the errors are assumed to be  $MA(1)$  is

$$LM_\rho = \sqrt{D' J^{-1} D} \quad (\text{A.47})$$

$$LM_\rho \stackrel{H_0}{\underset{Asy}{\rightsquigarrow}} N(0, 1).$$

Test statistics  $LM_\rho$  was used to test serial correlation of the models estimated in the main text.

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<sup>6</sup>See Baltagi (1995, p. 92) for complete derivation.

## **Appendix B**

### **Tables on Central Bank Independence Indices**

Table B.1. **Codes**

<p>ltype: Type of limit in government lending  1.00: if absolute cash amount  0.67: if percentage of CB's capital  0.33: if percentage of government's revenues  0.00: if percentage of government expenditures</p>	<p>lint: Limit of interest rates when lending to government  1.00: if must at market rate  0.75: if cannot be lower than certain floor  0.50: if cannot higher than certain ceiling  0.25: if not restricted  0.00: if no interest payment</p>
<p>lla: Limit on advances  1.00: lending prohibited  0.67: if lending subject to strict limits  0.33: if lending subject to acc. limits  0.00: if lending unlimited</p>	<p>too: Terms of office  1.00: if <math>\geq 8</math> years  0.75: if <math>\geq 6, \leq 8</math> years  0.50: if if equal to 5 years  0.25: if equal to 4 years  0.00: if smaller than 4 years</p>
<p>ldec: Who decides lending term  1.00: if controlled by the CB  0.67: if control attributed by law to CB  0.33: if control left by law negotiations between CB and the government  0.00: If control left to the government</p>	<p>lls: Limit on securitized lending  1.00: if prohibited  0.67: if subject to strict limit  0.33: if subject to accommodative limits  0.00: if unlimited</p>
<p>obj: Price stability as statutory objective  1.00: if only objective and CB has final authority  0.80: if only objective  0.60: if other non-conflicting objectives  0.40: if other conflicting objectives  0.20: if no objectives in CB charter  0.00: if only other objectives in CB charter</p>	<p>app: Appointment of CB Gov.  1.00: if appointed by CB Board  0.75: if appointed by legislative and executive branchers  0.50: if appointed by legislative branch  0.25: if appointed executive branch  0.00: if appointed by 1 or 2 members of executive branch</p>
<p>lwid: Width of circle of borrowers  1.00 if only central government  0.67: if central and state governments  0.33: if all of above plus private firms  0.00: if all of above plus private sector</p>	<p>off: Other office held  1.00: if prohibited  0.50: if subject to approval by executive branch  0.00: if not prohibited</p>

Table B.1 continues

<p>lmat: Maturity of loans to government  1.00: if limited to 6 months  0.67: if limited to 12 months  0.33: if limited to more than 12 months  0.00: if unlimited</p>	<p>mpo: Monetary policy formulation  1.00: granted to CB alone  0.67: if granted to both CB and Gov.  0.33: if CB's capacity only advisory  0.00: if granted to government alone</p>
<p>diss: Governor dismissal  1.00: if not possible  0.83: if possible only for nonpolicy reasons  0.67: if unconditionally possible by central bank Board  0.50: if conditionally possible by legislative branch  0.17: if conditionally possible by executive branch  0.00: if unconditionally possible by executive branch</p>	<p>conf: Conflict resolution  1.00: if attributed to central bank  0.80: if attributed to government only for non-objectives  0.60: if attributed to CB board, legislative and executive branches of the government  0.40: if unconditionally attributed to legislative branch  0.20: if conditionally attributed to executive branch  0.00: if unconditionally attributed to executive branch</p>
<p>lpr: Lending in primary market  1.00: if central bank forbidden to participate  0.00: if central bank allowed to participate</p>	<p>adb: Budgetary policy formulation  1.00: if active role for central bank  0.00: if no active role for central bank</p>



Table B.2.      **Construction of the Central Bank  
Independence Indices**

Based on Table B.1 above, Cukierman (1992) constructs composite indices for personal independence, policy independence, importance of price stability, financial independence and overall independence in the following way.

- PERI (personal independence) = unweighted average of too, app, diss, off.
- POLI (Policy independence) = weighted average of mpo, conf, adb, where weights are .25,.5,.25 respectively.
- OBJE (Central bank objectives) = obj.
- FINI (financial independence) = weighted average of variable lla, lls, ldec, lwid, ltype, lint, lpr.
- LVAU (overall independence) = unweighted average of PERI, POLI, OBJE, FINI.

KICBI differs from CUKI, because in KICBI, FINI = variable lls. We have chosen this because of a high degree of subjectivity with respect to codings of the other financial variables as explained in the main text. Moreover, KICBI, as well as indices above were updated with the recent changes in the central bank laws. See Table B.2 below. Otherwise

- KICBI= unweighted average of PERI, POLI, OBJE, FINI.

Table B.3. **Recent Changes in Central Bank Laws**

Country	Year	Main changes introduced,	Change in Code
Belgium	1993	The government cannot oppose the decision taken by the CB relating to its key tasks Extension of credit by the CB for the government forbidden	mpo: 0.0 → 1 lla: 0.0 → 1
France	1993	The CB shall formulate and implement monetary policy with the aim of ensuring price stability The CB shall neither seek nor accept instructions from the government or any person Credit for the government forbidden	obj: 0.20 → 1 mpo: 0.67 → 1 lla: 0.67 → 1
Greece	1992	Credit for the government forbidden	lla: 0.25 → 1
New Z	1989	Primary objectives defined as economic objectives of achieving and maintaining stability in the general price level. The Bank has sole authority to implement monetary policy, but override provision of the government exists. Governor can be missed from policy reasons	obj: 0.40 → 0.8 diss: 0.83 → 0.17

Table B.3. continues

Country	Year	Main changes introduced	Change in Code
Italy	1992 1993	Governor sets the official discount rate Credit for the government forbidden	int: 0.25 → 1 lla: 0.33 → 1
Sweden	1988	Term of office of the Governor extended to 5 years Credit for the government forbidden	too: 0.0 → 0.25 lla: 0.0 → 1
Spain	1994	Primary objective price stability but supports the general policy of the government if that does not conflict with price stability. Term of office of the governor extended to 6 years No instructions from the government in implementation of monetary policy Dismissal of governor restricted to non-policy reasons only Credit to the public sector prohibited	obj: 0.6 → 0.6 too: 0.25 → 0.75 mpo: 0.33 → 1 diss: 0.0 → 0.83 lla: 0.33 → 1

Sources: Cukierman (1992), Cottarelli and Giannini (1997, Table 7, p. 18) and various central bank laws.

Notes: Change of coding is based on own judgement of the central bank laws according to the main changes introduced. Changes are then translated into numerical values following the coding in table A.

# Appendix C

## Mathematical appendix for Chapter 3

### C.1 Proof for equation 3.37

**Proposition 10** *Sufficient condition for  $\frac{\partial y_t^{pc}}{\partial \delta_1} > 0$  is that  $\bar{g} > \frac{2}{1+N}$ , when  $\gamma = \frac{1}{N}$  and  $\beta_i = 0$*

**Proof.** First, we take the derivative of  $y_t^{pc}$  with respect to  $\delta_1$ . What follows is

$$\frac{\partial y_t^{pc}}{\partial \delta_1} = -\delta_2 \frac{(\gamma - 1)(\bar{g}(\gamma - 1) - \gamma)\delta_1^2 + 2(1 - \gamma)\bar{g}\delta_2\delta_1 + (\bar{g}\gamma + \bar{g} - 2\gamma)\delta_2^2}{(\delta_2 + \delta_1)^2(-2\delta_2 - \delta_1 + \gamma\delta_1)^2}.$$

First, notice that the denominator of the derivative is always positive within parameter range of interest. Then, we can write

$$\begin{aligned} \frac{\partial y_t^{pc}}{\partial \delta_1} &< 0 \\ &\Leftrightarrow \\ A\delta_1^2 + 2B\delta_2\delta_1 + C\delta_2^2 &< 0 \end{aligned}$$

where

$$\begin{aligned} A &= (\gamma - 1)(\bar{g}(\gamma - 1) - \gamma) > 0 \\ B &= (1 - \gamma)\bar{g} > 0 \\ C &= (\bar{g}(\gamma + 1) - 2\gamma) \geq 0. \end{aligned}$$

The polynomial  $A\delta_1^2 + 2B\delta_2\delta_1 + C\delta_2^2$  is always positive when  $A, B$  and  $C$  are positive. Since  $A$  and  $B$  are strictly positive for all  $\gamma < 1$  and  $0 < \bar{g} < 1$ , sufficient condition that  $\frac{\partial y_t^{pc}}{\partial \delta_1} > 0$  is that  $C > 0$ . That is

$$\begin{aligned} \bar{g}(\gamma + 1) - 2\gamma &> 0 \\ &\Leftrightarrow \\ \bar{g} &> \frac{2\gamma}{\gamma + 1} \\ &\Leftrightarrow \\ \bar{g} &> \frac{2}{1 + N}. \end{aligned}$$

**Proposition 11** Necessary condition for  $\frac{\partial y_t^{pc}}{\partial \delta_1} < 0$  is that  $\delta_1 < \tilde{\delta}_1$ , when  $\gamma = \frac{1}{N}$  and  $\beta_i = 0$ .

**Proof.** In order to find necessary condition, when  $\bar{g} < \frac{2\gamma}{\gamma+1}$  we solve the polynomial  $A\delta_1^2 + 2B\delta_2\delta_1 + C\delta_2^2$ . The two roots of this polynomial are

$$\begin{aligned} \hat{\delta}_1^1 &= \delta_2 \frac{\sqrt{(B^2 - AC)} - B}{A} \\ \hat{\delta}_1^2 &= -\delta_2 \frac{B + \sqrt{(B^2 - AC)}}{A} \end{aligned}$$

First, notice that since  $A, B > 0$  and  $C < 0$  the second root is always real but negative. Second, notice that the root  $\hat{\delta}_1^1$  is always positive. Then, clearly

$$\begin{aligned} 0 &< \delta_1 < \delta_2 \frac{\sqrt{(B^2 - AC)} - B}{A} = \tilde{\delta}_1 \\ &\Rightarrow \frac{\partial y^{pc}}{\partial \delta_1} < 0. \end{aligned}$$

After substitution of  $A, B$  and  $C$  we find that

$$\tilde{\delta}_1 = \frac{(1 - \bar{g})(-\bar{g} + (\bar{g} - 2)\gamma)\gamma}{(\gamma - 1)\bar{g} - \gamma} (1 - 2\bar{g}(1 - \gamma)) + \frac{(\gamma - 1)\bar{g}^2}{(\gamma - 1)\bar{g} - \gamma}.$$

## C.2 Proof for equation 3.47

**Proposition 12** *Sufficient condition for  $\frac{\partial y_t^{pc}}{\partial \delta_1} > 0$  is that  $\bar{g} > \frac{(5N-4)N+1}{(4(N-1)+N^2)N+1} > \frac{2}{1+N}$ , when  $\gamma = \frac{1}{N^2}$  and  $\beta_i = 0$ .*

**Proof.** Proceeding as above it can be shown that sufficient condition is

$$\frac{\partial y_t^{pc}}{\partial \delta_1} > 0 \forall \bar{g} > \frac{(5N-4)N+1}{(4(N-1)+N^2)N+1} > \frac{2}{1+N}.$$

**Proposition 13** *Necessary condition for  $\frac{\partial y_t^{pc}}{\partial \delta_1} < 0$  is that  $\delta_1 < \tilde{\delta}_1$ , when  $\gamma = \frac{1}{N^2}$  and  $\beta_i = 0$ .*

**Proof.** Proceeding as above, it is easy to show that when  $\bar{g} < \frac{(5N-4)N+1}{(4(N-1)+N^2)N+1}$ , the derivative  $\frac{\partial y_t^{pc}}{\partial \delta_1}$  changes the sign from negative to positive at

$$\tilde{\delta}_1 = \delta_2 \frac{\sqrt{(B^2 - AC)} - B}{A}$$

where

$$\begin{aligned} A &= (N-1)(\bar{g}(N-1) + (N-1)N+1) > 0, N > 1 \\ B &= (N-1)(\bar{g}(2N-1) + (N-2)N+1) > 0, N > 1 \\ C &= (((4+N)\bar{g} - 5)N + 4(1-\bar{g}))N + \bar{g} - 1. \end{aligned}$$



## Appendix D

# Table on the Sequence of Reforms in Inflation Targeting Countries

Table D.1. Sequence of Reforms in the Inflation Targeting Countries

Country	Inflation Targeting	Gov.	Next Gov.	CBI	Barg. level
New Zealand	Feb. 1990	Left	Right (91)	.27	2 → 1
Canada	Feb. 1991	Right	Liberal (93)	.46	1
The U.K.	Oct. 1993	Right	Left (96)	.31	2 → 1
Sweden	Jan. 1993	Right	Left (94)	.27	3 → 2
Finland	Feb. 1993	Right	Left (95)	.27	3 → 2/1
Australia	April 1993	Left	Right(96)	.31	2 → 3/1
Spain	July 1994	Left	Right (96)	.22	2/3 → 1

Sources: OECD (1994, 1997), Cukierman (1992), Election Studies.

Notes: Barg.level=Bargaining level; 1= company level wage bargaining, 2 = sectoral level wage bargaining, 3 = central level wage bargaining;→ direction of change in 1980-1994. CBI = legal independence of the central bank in 1980s; index ranges between 0 and 1. The greater the value, the more independent the central bank. Value in the brackets in row "Next Gov." indicates the year of the general elections. Row "Gov." refers to the government during the adoption of inflation targeting.





# Appendix E

## Mathematical appendix for Chapter 4

### E.1 Solution to wage setters' maximization problem in discretionary case

Solving (4.13) for union  $i$  yields

$$2w_{it} = \frac{N\gamma_i - 1}{1 + N^2\gamma_i - N\gamma_i} E_{-i} \left( \sum_{j \neq i} w_{jt} \right) + \frac{N + 1 + N^2\gamma_i - N\gamma_i}{1 + N^2\gamma_i - N\gamma_i} p_t^e + \frac{(N - 1)(1 - N\gamma_i)}{1 + N^2\gamma_i - N\gamma_i}. \quad (\text{E.1})$$

Each union must form beliefs  $E_{-i} \left( \frac{1}{N-1} \sum_{j=1}^{N-1} w_j \right)$ . Assuming that each union behaves symmetrically, it is also true that the union  $j$  sets

$$2w_{jt, j \neq i} = \frac{N\gamma_j - 1}{1 + N^2\gamma_j - N\gamma_j} E_{-j} \left( \sum_{i \neq j} w_{it} \right) + \frac{N + 1 + N^2\gamma_j - N\gamma_j}{1 + N^2\gamma_j - N\gamma_j} p_t^e + \frac{(N - 1)(1 - N\gamma_j)}{1 + N^2\gamma_j - N\gamma_j}. \quad (\text{E.2})$$

For notational simplicity, let

$$\begin{aligned} w_i &= a_i p_t^e + b_i E_{-i} \sum_{j \neq i} w_j + \sigma_i \\ w_j &= a_j p_t^e + b_j E_{-j} \sum_{i \neq j} w_i + \sigma_j \end{aligned}$$

where  $a_i = \frac{1}{2} \frac{N+1+N^2\gamma_i-N\gamma_i}{1+N^2\gamma_i-N\gamma_i}$ ,  $\sigma_i = \frac{1}{2} \frac{(N-1)(1-N\gamma_i)}{1+N^2\gamma_i-N\gamma_i}$ ,  $b_i = \frac{1}{2} \frac{N\gamma_i-1}{1+N^2\gamma_i-N\gamma_i}$  and  $i = j$ .

Assuming perfect foresight, symmetric and rational beliefs and that  $\gamma_i = \gamma_j = \gamma$  it is enough to consider

$$w_{it} = a_i p_t^e + b_i \sum_{j \neq i} w_{jt} + \sigma_i. \quad (\text{E.3})$$

Due to the symmetry, equation above can be written

$$w_i = a_i p_t^e + b_i (N-1) w_i + \sigma_i. \quad (\text{E.4})$$

Substituting  $a_i, b_i, \sigma_i$  and solving for  $w_i$  yields

$$w_i = p_t^e + \sigma_h \quad (\text{E.5})$$

$$\sigma_h = \frac{(1-N\gamma_i)(N-1)}{1+(\gamma_i(N-1)+1)N}. \quad (\text{E.6})$$

Finally, due to the symmetry

$$w_{it} = w_t = p_t^e + \sigma_h$$

## E.2 Proof that wage setters' precommitment is time inconsistent

**Proposition 14** *Unions precommitment is time inconsistent and in particular,*

$$\frac{\partial E_t(u_{it})}{\partial w_{t|\pi_t=\pi^{pc}|w_t=w_t^{pc}}} < 0.$$

**Proof.** First, notice that

$$\begin{aligned} \frac{\partial E_t(u_{it})}{\partial w_t | \pi_t = \pi^{pc}} &= \frac{1 + p_{t-1} + \pi^* + \lambda \sigma_{pc} - w_t}{N} - (1 + w_t - p_{t-1} - \pi^* - \lambda \sigma_{pc}) \\ &\quad \times \left( \frac{1}{N^2} + \gamma \left( 1 - \frac{1}{N} \right) \right). \end{aligned} \quad (\text{E.7})$$

Substituting then optimal wage rule

$$w_t^{pc} = p_{t-1} + \pi^* + (1 + \lambda) \sigma_{pc}$$

we obtain

$$\frac{\partial E_t(u_{it})}{\partial w_t | \pi_t = \pi^{pc} | w_t = w_t^{pc}} = \frac{(N-1)(1-\gamma N) - (1+N+\gamma N^2-\gamma N)\sigma_{pc}}{N^2}. \quad (\text{E.8})$$

It is then easy to see that

$$\begin{aligned} \frac{\partial E_t(u_{it})}{\partial w_t | \pi_t = \pi^{pc} | w_t = w_t^{pc}} &< 0 \\ &\Leftrightarrow \\ \frac{(N-1)(1-\gamma N)}{(1+N+\gamma N^2-\gamma N)} &< \frac{(N-1)(1-\gamma N)}{\frac{1-\lambda}{1+\lambda} + N + \gamma N^2 - \gamma N} \\ \sigma_h &< \sigma_{pc} \\ &\Leftrightarrow \\ 1 &> \frac{1-\lambda}{1+\lambda}. \end{aligned} \quad (\text{E.9})$$

The last statement is always true for all  $0 < \lambda < \infty$ ,  $N < \frac{1}{\gamma}$ .

### E.3 Proof that weight conservative central banker improves welfare of the government in inflation targeting regime

**Proposition 15** *A weight conservative central banker improves social welfare when the central bank has an explicit inflation target, while a populist central banker leads always into decrease in social welfare.*

**Proof.** Let  $\lambda_G$  denote the government's accommodation parameter and  $\lambda_{cb}$  the central bank's accommodation parameter. Let  $E[V_t]_s$  denote expected loss of the government when the preferences of the central bank and the government are separate and  $E[V_t]_c$  when the preferences are the same. When the target inflation for the central bank is chosen so that socially optimal target  $\pi^*$  is achieved, expected loss of the government  $E[V_t]_s$  can be written

$$E_t[V_t]_s = \frac{1}{1-\beta} \frac{1}{2} \left( \left( \frac{1}{1+\lambda_{cb}} \right)^2 (\lambda_{cb}^2 + \lambda_G)v^2 + \lambda_G \sigma_{pc}^2 \right).$$

Comparing this loss to the case where the central bank shares the preferences of the government, we notice after some manipulations that

$$\begin{aligned} E_t[V_t]_s &> E_t[V_t]_c \\ &\iff \\ \frac{(\lambda_G - \lambda_{cb})^2}{\lambda_G (1 + \lambda_{cb})^2 (1 + \lambda_G)} v^2 &\geq (\sigma_{pcc}^2 - \sigma_{pcs}^2) \end{aligned} \quad (\text{E.10})$$

where

$$\begin{aligned} \sigma_{pcc} &= \frac{(N-1)(1-\gamma N)}{\left( \frac{1-\lambda_G}{1+\lambda_G} + N(\gamma(N-1)+1) \right)} \\ \sigma_{pcs} &= \frac{(N-1)(1-\gamma N)}{\left( \frac{1-\lambda_{cb}}{1+\lambda_{cb}} + N(\gamma(N-1)+1) \right)} \end{aligned}$$

**Lemma 16** *When  $\lambda_{cb} > \lambda_G$  the loss of the government is always larger when compared with the case where  $\lambda_{cb} = \lambda_G$ .*

**Proof.** The left hand side of the (E.10) is always positive in the parameter range of interest. Notice then that  $\sigma_{pc}$  is increasing in  $\lambda$ , so that when  $\lambda_{cb} > \lambda_G$  right hand side is always negative. Therefore

$$\begin{aligned} \lambda_{cb} &> \lambda_G \\ &\implies \\ E_t[V_t]_s &> E_t[V_t]_c. \end{aligned}$$

This completes the proof that populist central banker cannot be welfare improving.

**Lemma 17** *There exist a non-empty range of  $0 \leq \lambda_{cb} < \lambda_G$ , where*

$$E_t[V_t]_s < E_t[V_t]_c.$$

**Proof.** Recall that

$$E_t[V_t]_s = \frac{1}{1-\beta} \frac{1}{2} \left( \left( \frac{1}{1+\lambda_{cb}} \right)^2 (\lambda_{cb}^2 + \lambda_G)v^2 + \lambda_G \sigma_{pc}^2 \right).$$

Taking the the derivative with respect to  $\lambda_{cb}$ , we obtain

$$\frac{\partial E_t[V_t]_s}{\partial \lambda_{cb}} = \frac{1}{1-\beta} \frac{1}{2} \left( 2 \frac{\lambda_{cb} - \lambda_g}{(\lambda_{cb} + 1)^3} v^2 + \lambda_G \frac{\partial \sigma_{pc}^2}{\partial \lambda_{cb}} \right).$$

Remembering that  $\frac{\partial \sigma_{pc}^2}{\partial \lambda_{cb}} > 0$ , a necessary condition that the derivative is  $\frac{\partial E_t[V_t]_s}{\partial \lambda_{cb}}$  is zero within the parameter range of interest is that  $\lambda_{cb} < \lambda_g$ . Notice then that

$$\begin{aligned} \frac{\partial E_t[V_t]_{\lambda_{cb} \rightarrow \lambda_g}}{\partial \lambda_{cb}} &> 0 \\ \frac{\partial E_t[V_t]_{\lambda_{cb} \rightarrow 0}}{\partial \lambda_{cb}} &< 0. \end{aligned}$$

Then it is clear that  $\frac{\partial E_t[V_t]}{\partial \lambda_G}$  changes the sign between  $0 \leq \lambda_{cb} < \lambda_G$ , so that appointment of conservative central banker is welfare improving for the government.

## E.4 Proof that inflation targeting is preferred always when $N \geq 3$

**Proposition 18** *When the wage setters have precommitted and  $N \geq 3$ , an inflation targeting is preferred over discretion independently on the weight of accommodation parameter  $\lambda$ . If  $N < 3$ , preference of inflation targeting over discretion depends upon accommodation parameter  $\lambda$ .*

**Notation 19** *Let  $A = N(\gamma(N-1) + 1)$ . The condition (4.60) can be written*

$$\left( \frac{1+A}{\frac{1-\lambda}{1+\lambda} + A} \right)^2 < 1 + \lambda. \quad (\text{E.11})$$

First, notice that  $\lambda$  has three roots. These are

$$\lambda_1 = 0 \quad (\text{E.12})$$

$$\lambda_2 = \frac{3 + A(2 - A)}{1 + A(A - 2)} \quad (\text{E.13})$$

$$\lambda_3 = -1. \quad (\text{E.14})$$

Since only values  $\lambda > 0$  are of interest we need to consider the root  $\lambda_2$ , which is decisive to the preference for the targeting over discretion. More closely, we will now show that there exist positive  $\lambda$  such that  $0 < \lambda < \tilde{\lambda} = \lambda_2$ , where discretion would be preferred over explicit inflation targeting.

For expositional simplicity, let  $\eta(A, \lambda) = \left( \frac{1+A}{\frac{1-\lambda}{1+\lambda}+A} \right)^2$ .

**Lemma 20**  $\lambda_2 > 0$  iff  $N < 3$ . Therefore, inflation targeting is always preferred iff  $N \geq 3$ .

**Proof.** First, notice that  $\frac{\partial \lambda_2}{\partial A} = \frac{8}{(1-A)(A-1)^2} < 0 \forall A \in (N, 2N - 1)$ . Second, notice that  $\lambda_2 = \frac{3+A(2-A)}{1+A(A-2)} = 0 \Leftrightarrow A = -1$  or  $A = 3$ . Then because  $\frac{\partial \lambda_2}{\partial A} < 0 \forall A \in (N, 2N - 1) \Rightarrow \lambda_2 > 0$  iff  $A < 3$ . Finally it is easy to show that  $A < 3$  iff  $N < 3 \Rightarrow \lambda_2 > 0$  iff  $N < 3$ .

**Lemma 21** There exist  $0 < \lambda < \tilde{\lambda} = \lambda_2$  such that  $E[V_t^{Tpc}] > E[V_t^d]$ . When this is the case, discretion is preferred over targeting.

**Proof.** Given that  $\lambda_2 > 0$  for some  $N \in (1, \frac{1}{\gamma})$  and that  $\eta(A, 1) = 1$  it is enough to show that  $\eta(A, \lambda)$  is a concave function of  $\lambda$  for some non-empty range of  $\lambda$  such that  $0 < \lambda < \lambda_2$ . We know already that  $\frac{\partial \eta(A, \lambda)}{\partial \lambda} > 0$ . Clearly,  $\frac{\partial^2 \eta(A, \lambda)}{\partial \lambda \partial \lambda} = -8(1+A)^2 \frac{\lambda(A-1)+A-2}{(\lambda A - \lambda + 1 + A)^4} < 0$  iff  $\lambda(A-1) + A - 2 > 0 \Leftrightarrow \lambda > \frac{2-A}{A-1} \forall A > 1$ . This is true always when  $A > 2$ . Finally, we show that range  $\lambda \in \left( \frac{2-A}{A-1}, \frac{3+A(2-A)}{1+A(A-2)} \right)$  is non-empty. It is enough to show that  $\frac{2-A}{A-1} < \frac{3+A(2-A)}{1+A(A-2)}$  for some  $A > 2$ . To show this notice that  $\frac{2-A}{A-1} < \frac{3+A(2-A)}{1+A(A-2)} \Leftrightarrow \frac{A-5}{1+(A-2)A} < 0 \Leftrightarrow A < 5 \forall A > 2$ . Since  $\eta(A, \lambda)$  is concave function of  $\lambda$  when  $A > 2$  and  $\lambda_2 > 0$  when  $A < 3$  it is clear that there exist such non-empty range of  $\lambda$ ,  $0 < \lambda < \tilde{\lambda} = \lambda_2$  where  $E(V_t^{Tpc}) > E(V_t^d)$ .