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BACKGROUND STUDY FOR THE EVALUATION OF THE ECB'S MONETARY POLICY STRATEGY

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DIEGO RODRÍGUEZ PALENZUELA, GONZALO CAMBA-MÉNDEZ AND JUAN ÁNGEL GARCÍA

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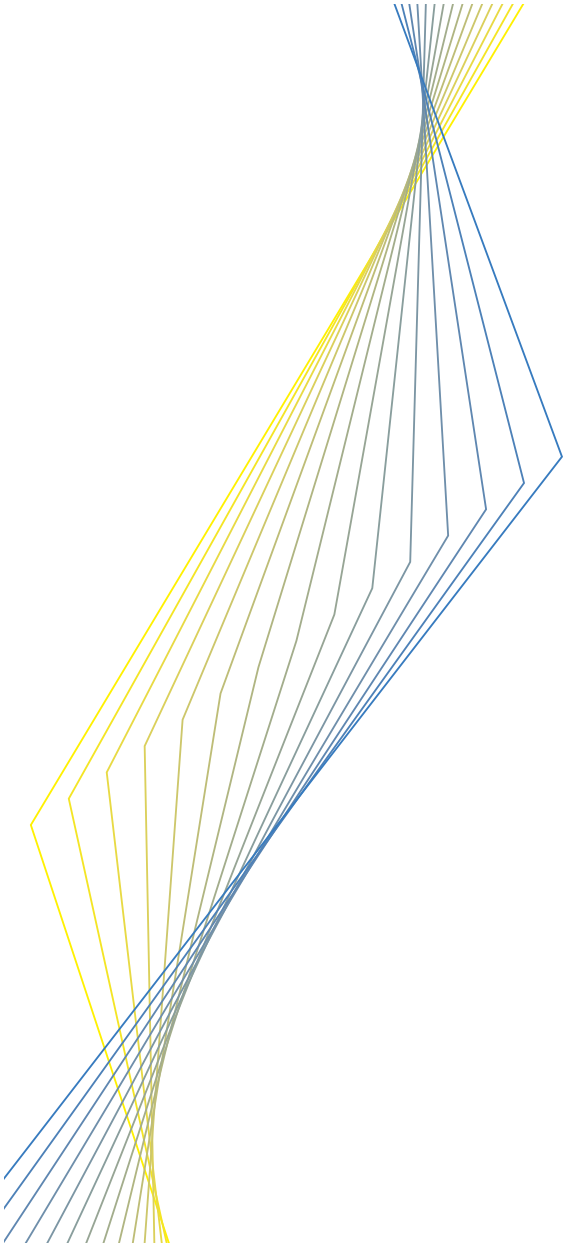

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# RELEVANT ECONOMIC ISSUES CONCERNING THE OPTIMAL RATE OF INFLATION[1]

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**Abstract**

This paper reviews the key economic issues concerning the welfare costs of inflation and deflation, with a view to shedding light on the desirable properties of the inflation process. Our review of the evidence on the overall costs of inflation and deflation indicates that such costs could be even higher than previously thought, also at moderate rates of inflation, thereby strengthening the case for price stability. We also review two of the arguments usually invoked for maintaining a small positive rate of inflation: the potential alleviation of poor economic performance arising from downward nominal rigidities and the role of sustained inflation differentials within the euro area. Recent evidence suggests that the macroeconomic relevance of these two factors is minor, even when considered in combination, although this assessment remains surrounded by high uncertainty.

KEYWORDS: Price stability, inflation costs and benefits, downward nominal rigidities, inflation differentials, deflation

JEL Classification Numbers: D60, E31, E41, E61, H21

## NON-TECHNICAL SUMMARY

This paper reviews the key economic issues concerning the welfare costs and economic effects derived from inflation and deflation, with a view to shedding light on the desirable properties of the inflation process.

The paper is divided in two main parts. A first part of the paper (corresponding to Section 2) is devoted to reviewing the economic literature that considers and estimates the economic effects, notably the welfare costs, of inflation and deflation. This part of the paper starts by summarising the work that gauges the link between observed inflation and real GDP growth over medium to long-term horizons. The recent literature confirms earlier results of a clear negative relationship between inflation and economic growth. In this respect, threshold effects are generally found, indicating that the negative effects of inflation on growth are visible for inflation rates above moderate levels.

The first part of the paper also reviews the literature on the links between the characteristics of price trends in a given monetary regime and economic welfare. Under the view that virtually all characteristics of the inflation process are potentially relevant and informative for designing key elements of a monetary policy strategy, the focus here is on assessing in a comprehensive fashion all aspects of the inflation process that may impinge on economic welfare. Four main sources of welfare costs associated to departures from price stability are found to be particularly important. First, costs resulting from the interaction between inflation and the tax system. Second, costs caused by the presence of nominal rigidities: namely i) menu costs (i.e., the cost of changing prices) and ii) *nominal lock-in* (i.e. the inability to change prices within a given time interval). In this respects, recent work suggests that, in the presence of symmetric nominal rigidities, the optimal inflation rate is zero (so as to minimise the distortions of nominal rigidities on relative prices). Third, effects resulting from changes on income distribution. Fourth, direct costs of inflation, among which two main types are distinguished: i) reduced consumer surplus from real balances (the so-called *shoe-leather* costs), and ii) excessive allocation of resources to the financial system.

The empirical evidence confirms that even moderate rates of inflation are likely to entail significant welfare losses. This evidence includes recent work that has tackled the measurement of the welfare costs of inflation within the framework of dynamic general equilibrium models. In general, these superior estimates further strengthen the case for price stability.

In a second part of the paper (corresponding to Section 3), the literature pertaining to the main arguments often invoked for central banks aiming to keep inflation above zero is reviewed. In this respect, two main arguments are considered.

A first argument in this respect relates to the existence of downward nominal rigidities in prices and labour costs. Three conclusions are drawn. A) The evidence of downward nominal rigidities in *prices* in the euro area seems weak. B) The literature on downward nominal rigidities in *labour costs* has

developed with a relative disconnection between invoked theoretical or conceptual foundations on the one hand and the establishment of empirical regularities on the other. In this respect we argue that the relative agreement in pointing to factors of psychological nature, notably money illusion, to underpin such rigidities conceptually, while being perfectly legitimate in itself, poses considerable new challenges for extracting normative or policy implications when such rigidities are present. C) The evidence of downward nominal rigidities is markedly uneven across countries and seems to strongly depend on countries' institutional factors. This favours the view that structural economic policies have a large room of manoeuvre to tackle these issues. In particular, the available evidence in this respect suggests that whenever flexible forms of contracting in labour markets are present, the macroeconomic relevance of nominal downward rigidities tends to vanish. Taken together, these considerations favour the conclusion that nominal downward rigidities would seem an only secondary factor for determining the safety margin for inflation rates above zero.

The second argument on the potential benefits of maintaining inflation above zero that we consider relates to the simultaneous presence of nominal downward rigidities and inflation differentials in a monetary union. In this respect, it is pointed out that the available evidence seems still too scant to permit a highly precise assessment of the nature and sources of inflation differentials of a lasting nature in a currency union. Nonetheless, the existing evidence on the magnitude of the Balassa-Samuelson effect in the euro area does not suggest that the previous view (against the relevance of downward nominal rigidities as an important consideration for defining price stability in the euro area) needs to be revised.

The paper concludes with the more general consideration of how to determine the appropriate small safety margin for the price stability objective. For this, we first briefly take stock on a further argument for central banks aiming at small positive inflation rates in the literature (which moreover could be seen as the most prominent one), namely the need to keep a safety margin for inflation rates above zero to dispel deflationary concerns. Although this major branch of the literature on optimal inflation is not the main focus of this paper, recent studies conducted for the euro area are briefly discussed. These studies suggest that the chances of the ECB being required to lower interest rates to zero and then effectively being constrained by the zero lower bound are rather small for inflation objectives above 1% per annum. Finally, in the concluding section we caution against the risk of 'double-counting' the benefits of an extra margin in the price stability objective if each of the relevant factors is considered in isolation from the other factors. Instead, gauging the size of the appropriate safety margin for inflation rates requires a sound judgement, supported by model-based evidence, encompassing all the relevant factors simultaneously.

# 1. Introduction

A widespread support for price stability as the overriding objective of monetary policy emerged after the period of high inflation experienced in the 1970s in most industrialised countries. Gradually all central banks have committed to maintain the rate of inflation within a comfort zone, with a view to keep inflation stable at low levels and also to exclude deflation. Indeed, monetary policy frameworks nowadays usually feature an explicit definition of price stability or an inflation target (both in terms of point targets and ranges). These have broadly converged in the last decade to the approximate range of 0% to 3½%.

The implication of this explicit commitment to maintain price stability should not be overlooked. In modern economies, which are characterised by highly decentralised markets, the characteristics of the inflation process (e.g. as regards its mean, volatility and its relationship with other variables in the economy) are relevant for virtually all decisions taken by economic agents. The importance assigned by economists in the last decades to this issue is therefore not surprising, and central banks are certainly not indifferent to developments in this front.

In this context, this paper provides a survey of the literature on some of the relevant economic issues relevant for defining the price stability objective of a central bank. Our analysis focuses on: a) the existing evidence on the costs of inflation and deflation, b) the potential mitigating effects of positive inflation rates in the presence of downward nominal rigidities, as well as in the case where the latter combines with persistent regional inflation differentials within a large currency union. Although our main interest is on the economic welfare costs of inflation and deflation in the euro area, we also review the available empirical evidence for other economies, notably the US, and indeed most of the conclusions drawn would seem to apply more generally to any large and developed currency area.

The main conclusions in the paper may be summarised as follows. As regards the costs of inflation and deflation, the undesirability of inflation is underpinned by the high degree of aversion to departures from price stability systematically expressed by the public in surveys[1] and also by the results of research on the effects of inflation and deflation. Economic research has uncovered a number of channels through which inflation and deflation significantly reduces welfare. Specifically, some of these channels, like distortions stemming from the interaction of inflation and the tax system, have been systematically found to be a source of substantial welfare losses. Other channels, like agents' efforts to economise on real balances and the over-development of the financial system resulting from inflation, have robustly been found to entail significant (albeit more limited) losses in welfare. Experts have also pointed to potential 'benefits' of small positive rates of inflation (namely, preventing that nominal downward rigidities and the zero

[1] See Shiller (1997) for a review.

lower bound on nominal interest rates become binding restrictions and avoiding effective deflation if there is a positive and significant upward bias in the overall consumer price index). [2]

Economists have attempted to gauge the magnitude of each of these costs and 'benefits' of inflation both in terms of welfare and economic performance. However, the assessment of the overall effect of inflation is hindered by a number of factors. First, the practical importance of these effects from inflation has been estimated until recently only on a *partial* basis: even though they are usually analysed in general equilibrium frameworks, the driving factors have tended to be analysed only one by one, often disregarding the interactions of the different factors. Second, some of the effects that were deemed potentially relevant have proven to be particularly elusive. This is particularly the case for nominal downward rigidities as a rationale for maintaining positive rates of inflation.

The recent contributions to the discussion on the optimal rate of inflation may be characterised by the higher generality and completeness of the analytical frameworks used to set up the question. These studies extend the dynamic general equilibrium frameworks used in earlier studies by considering simultaneously a number of relevant channels from inflation to welfare. A notable property of these 'all-encompassing' structural approaches is that they often allow for a fully explicit derivation of the optimal rate of inflation.[3] Interestingly, the available results in this vein thus far have tended to make an even stronger case for the objective of price stability.

In sum, taking the results as a whole, the evidence on the estimated costs and potential 'benefits' (including measurement bias and zero lower bound for nominal interest rates considerations) of alternative long-term inflation rates provides strong support for the objective of low inflation.

As regards the specific costs of deflation, in contrast with the analysis of the costs of inflation, the discussion has in general not been centred on the calculation of the economic welfare costs associated to each rate of deflation. Rather, the primary concern in this respect has been the more general issue of the overall controllability of price developments in the vicinity of zero inflation, in particular in connection with the risks of emergence of self-fulfilling deflationary expectations and eventually a liquidity-trap. Welfare costs related to these possibilities are difficult to gauge but are generally seen as being of a higher order relative to the costs of moderate inflation.[4]

From a specific euro area perspective, two main considerations may be highlighted. First, at least *a priori*, it may not be ruled out that the combination of sustained inflation differentials across euro area countries and nominal downward rigidities (at least in the lower inflation euro area countries) could hamper the

[2] The important issues of the lower bound on nominal interest rates and the potential bias in measures of inflation are not treated in this paper.

[3] Looking forward, these developments suggest that, as economic knowledge progresses further and the 'all-encompassing' approach delivers better estimates of the optimal inflation rate, it is likely that the relative weight of the scientific content will tend to increase at the expense of the judgmental content to buttress the assessment of the optimal rates of inflation.

[4] This, together with other considerations, advises that monetary policy should aim at maintaining inflation above a certain safety margin, rather than a literal interpretation of price stability (i.e. zero inflation).

performance of lower inflation countries (which need to operate with inflation rates lower than the Eurosystem's average). However, such rigidities could tend to disappear as the low inflation regime becomes fully ingrained in agents' expectations and wage bargaining practices. Second, there is a notable imbalance in the number of available studies in favour of the US, compared to the euro area. However, the extent to which results based on US data could be extrapolated as relevant knowledge for the euro area is not always clear.

The rest of the paper is organised as follows. Section 2 reviews the existing evidence on the welfare costs of the inflation process, with a view to characterising all aspects in which inflation may impinge on the economy (e.g. including both the effects of anticipated and non-anticipated inflation). The focus here is primarily targeted towards the more recent contributions to the literature. Section 3 considers the contributions that highlight the potential benefits from positive rates of inflation. In particular, Section 3.1 addresses the issue of nominal downward rigidities in prices and wages. Section 3.2 reviews and discusses the potential implications from the simultaneous presence of downward nominal rigidities and heterogeneity in the inflation rates for the optimal rate inflation in a large currency area. Finally, concluding remarks are presented in Section 4.

## 2. Costs of Inflation

This section reviews the literature on the main channels through which inflation negatively affects economic performance, first in terms of long-term growth and second in terms of welfare. However, given the vastness of the underlying literature, it is necessary to restrict somewhat the scope of our survey. In this respect we aim at reviewing the literature which sheds light on the welfare costs associated with the process of inflation associated to a given monetary policy regime. That is, our interest relates primarily to the welfare implications of a given inflationary process, rather than the properties of the inflationary process that is likely to emerge under an optimal scheme for monetary policy, however defined.

A second feature of our survey is that we put a relatively small emphasis on distinguishing the welfare effects of the so-called anticipated versus unanticipated components of inflation. This is for a number of reasons. First, it is our view that any monetary policy strategy ultimately impinges on virtually all aspects of the price formation process (i.e. in more technical terms, on both the unconditional and conditional mean and volatility of the inflation process). The existing knowledge on the welfare costs of unanticipated inflation is thus also of interest for central banks. Second, it cannot be ruled out that the structural features of the economy imply a systematic empirical relation between the mean of inflation over long horizons and the standard deviation of the medium and short-term trends around that mean. This would imply that in setting an inflation objective, a direct impact on inflation volatility could need to

be weighted, which may require an assessment of the costs associated to the less predictable component of the inflation process.[5]

Finally, in the review following, the recent general equilibrium contributions that gauge the overall effects of inflation when they operate simultaneously through various channels are given particular attention.

## 2.1. Effect of inflation on long-term growth

The relationship between inflation and long-term growth has been extensively studied. There is growing consensus in that high rates of average inflation (in the order of 15% and above[6]) have a considerable negative impact on long-term GDP growth. The link between growth and inflation seems less clear cut for lower average rates of inflation, at least on the basis of reduced-form estimates (see for instance Bruno and Easterly (1998) and Issing (2001) for a summary of empirical findings in this regard). However, some recent studies (e.g. Andrés and Hernando (1999)[7]) continue to find a negative impact of inflation on long-term growth.

The empirical ambiguity in the reduced form relation between inflation and long-term growth might reflect the fact that in the reduced form approach a number of complex structural effects tend to counter each other. First, the relationship between growth and inflation is likely to be different at business cycle frequencies (which tend to exhibit a positive relation) and at lower frequencies (which are more likely to yield a negative relation). Second, the effect of high average inflation on growth is likely to depend on the characteristics of the country, in particular on the degree of development of the financial system.

Taken together, these structural effects suggest that evidence from reduced form regressions relating growth and inflation is likely to be of limited use for understanding the working of the effects from sustained inflation on long term economic performance. In contrast to the reduced-form approach, Dotsey and Sarte (2000) tackle this question within a structural model calibrated for the U.S. economy. Building on a neo-classical endogenous growth model with money, their calibrated model is able to reproduce the structural effects mentioned above. Interestingly, Dotsey and Sarte (2000) find that higher average inflation has a negative effect on steady-state growth (due to higher transaction costs from inflation in the money market). By contrast, they argue that higher inflation volatility has a more ambiguous effect on growth. This is because higher inflation volatility has a positive impact on precautionary savings, which fosters growth in their setting. However, higher inflation volatility entails an unambiguous decline in

[5] More generally, it could be argued that the distinction between the costs of anticipated vs. non-anticipated inflation is all but clear-cut. For instance it is sometimes argued that it is unanticipated inflation which puts a veil on relative price signals, leading to the misallocation of resources. However, even if inflation rates can be accurately anticipated over the long run in a context where the central bank credibly aims at a given rate of inflation, the price level may be difficult to predict over long horizons, making it more difficult to value certain assets.

[6] See Barro (1995) for a detailed discussion.

welfare, even if the effect on growth could be positive, since the latter works through a precautionary savings effect (i.e. consumers are "forced" to save –or work- more to procure themselves insurance against more volatile shocks). Overall, they find that the negative effect on growth of higher average inflation clearly overwhelms the positive effect from higher inflation volatility, thereby supporting the view that higher inflation has a predominantly negative impact on growth performance.

## 2.2. Effect of inflation on welfare

The economic literature highlights a number of channels through which inflation becomes costly. They may be grouped under the following categories[8]:

- Noise in the information content of relative prices.
- Nominal rigidities.
- Distortions in taxation.
- Direct transaction costs from inflation.
- Income redistribution.

### 2.2.1. 'Noise' in the information content of relative prices

Both inflation and deflation are costly because of their distortionary impact on relative prices across the economy and thus on the efficiency of market allocations. Lucas (1973) suggested that relative prices might be affected by inflation if suppliers of a given good fail to identify the cause of a given increase in the nominal demand for their good. This increase may be caused either by an aggregate shock to nominal money supply, or a sector specific shock, i.e. a relative shift in real demand towards the agent's good. Suppliers would not like to adjust the quantity supplied of their good in the first case, but would like to respond to the second type of shock. Whenever agents do not correctly interpret the signals provided by the market system and make economic decisions based on these incorrect inferences, misallocation of resources results.

Horwitz (2002) suggested that the costs of inflation listed above, which represent those captured by 'mainstream' macroeconomic analyses, may be much greater if one is to adopt the theoretical framework of 'Austrian' economists. From this more radical point of view, prices act as surrogates for the frequently contradictory information generated by a disequilibrium market process. A key function played by

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[7] They find that reducing the rate of inflation from 20% to 19% could imply a permanent increase in output by 0.5%. Furthermore, their analysis suggests that the positive effect on permanent output of decreasing inflation could be significantly higher at lower rates of inflation.

[8] In this respect, a distinction is sometimes introduced between costs of anticipated and unanticipated inflation. Although this distinction may be useful for some purposes, an attempt to classify here the costs of inflation in these terms would detract from the clarity of the exposition without adding necessarily many insights. In particular, if there were a link between the level and volatility of inflation, the distinction between costs of anticipated versus unanticipated inflation becomes less useful. Moreover, if contract indexation is difficult or costly, such distinction becomes void.

relative prices is that of facilitating market discoveries by entrepreneurs. Distortions in relative prices due to inflation thus undermine those tasks that are central to entrepreneurial activity and discovery in a market process. This means that such effects do not only take the form of temporary economic inefficiencies but they impinge more fundamentally on the functioning of key institutions in the economic process, with persistent effects.

### 2.2.2. Nominal rigidities

Economists have argued that the interaction of nominal rigidities[9] in prices and/or wages with both inflation and deflation entail welfare costs. In this regard, two issues should be considered. First, what is the empirical evidence of nominal price and wage rigidities? Second, what are the welfare implications of higher inflation in the presence of nominal rigidities? Regarding the first question, the more recent evidence suggests that, at least for the US, nominal price rigidities are less relevant than previously thought. Bils and Klenow (2002) find for a large sample of consumer goods in the US that price changes for individual goods occur with an average frequency of 4.3 months.[10]

More indirect evidence on nominal rigidities is obtained from model based estimates. Nominal rigidities have been introduced in models in two main different forms: Menu costs (i.e. a small fixed costs incurred every time that a price or wage is changed) and "nominal lock-in" (i.e. sellers inability to modify listed prices in certain periods)[11]. Examples of nominal lock-in are the so-called Taylor contracts (i.e. the inability to modify wages for a fixed, determined period, as modelled in Taylor (1979)), and the so-called Calvo-pricing (i.e. the inability to modify prices for a period of random duration, as modelled in Calvo (1983)).

#### i) Menu costs

A cost of inflation is brought about by the so called 'menu costs' of changing prices[12]. Levy et al (1997) and Dutta et al (1999) extended the definition of 'menu costs' to those which result from: a) the (labour) costs of changing shelve prices, b) the costs of printing the new price labels, c) mistakes made during the process of changing prices, and d) costs of supervising the process. The development of e-commerce has prompted some authors to suggest that the nominal rigidities in prices associated with 'menu costs' are soon to be a feature of the past. But this assertion is at odds with the empirical evidence presented in Chakrabarti and Scholnick (2001), that reported that prices charged by online booksellers exhibit within-store-synchronisation of price changes no less marked than for traditional retailers. This puzzle may be easily solved if a broader definition of 'menu costs', which also includes the management costs associated

[9] This should be distinguished from the issue of nominal downward rigidities, which have been pointed to as a potential rationale for targeting positive inflation rates.

[10] Further evidence for a relatively low level of nominal rigidity in micro data is reported in Golosov and Lucas (2003) in the context of the U.S. retailing sector.

[11] The effects of these two forms of nominal rigidity are particularly difficult to distinguish empirically. Estimates of the welfare costs from inflation from such nominal rigidities tend to rely on model calibration and simulation.

with the process of changing prices, is to be adopted. The management costs are those associated with the time spent by managers in assessing all their available information and making a decision on changing prices and will result regardless of whether inflation is anticipated or unanticipated. These "management" or "planning" costs could in principle be substantially exacerbated by price instability, as it would make the outcome of certain investment opportunities more uncertain. This would force economic agents to divert resources from productive investments to devote them both to a more detailed analysis of the likely returns of an investment project under different price scenarios and also to insure themselves against the risks of price uncertainty.

**ii) Nominal *lock-in***

From a theoretical perspective, nominal lock-in (either in the form of 'Taylor contracts' or 'Calvo-pricing') has proven to be a useful hypothesis to explain price inertia. In addition, recent research (e.g. Gali and Gertler (1999) and Gali et al. (2001)) finds support for the existence of nominal rigidities[13]: estimates that sellers in the euro area may change prices in a frequency of only between 3 and 4 quarters on average.[14] For the US the estimated average frequency of price changes is in the range of 2 to 3 quarters.[15] This has direct implications on aggregate welfare and the optimal rate of inflation: nominal lock-in hinders the adjustment of relative prices, reducing economic efficiency. Importantly, any departure from price stability would exacerbate this loss in efficiency from nominal lock-in. This is because firms subject to nominal lock-in in a given period suffer a distortion in their relative price that increases proportionally with the rate of growth of the overall price index.

This strand of the literature that gives a prominent role to the presence of nominal lock-in has a clear implication on the optimal rate of inflation: monetary policy should aim at price stability (i.e. zero inflation) to minimise the distortion on relative prices. However, the welfare costs of targeting a positive rate of inflation have yet not been estimated in this analytical framework.

### 2.2.3. Distortions in taxation

The tax system, even in industrial countries, and even in the absence of inflation, causes losses of economic efficiency since it distorts agents' economic decisions, and the presence of inflation may exacerbate these distortions.[16] In particular, tax systems have been found to be particularly distortionary

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[12] This approach follows the seminal contributions by Mankiw (1985) and Akerlof and Jellen (1985).

[13] However, these papers do not clarify entirely what type of nominal rigidity –menu costs or nominal lock-in- is empirically more relevant. Instead, different forms of nominal rigidity tend to be chosen in terms of their analytical convenience.

[14] Obviously, these results are not easy to reconcile with the micro-based estimates of nominal rigidity reported in Section 2.2.2., which point to a significantly lower degree of rigidity. Recent work exploring the interaction between nominal and real rigidities in the context of non-walrasian labour markets helps to alleviate this tension between micro and macro-based estimates of nominal rigidity (in this respect see e.g. Walsh (2003)).

[15] This seems to be a fair account of the consensus view in the literature. However, as cited before, recent work by Bils and Klenow (2002) has somewhat challenged this view.

[16] A tax system that introduces no inefficiencies would be based on lump-sum taxes. This is prevented by fairness and political economy considerations.

in their tendency to reduce the rate of capital accumulation and to induce over-investment in owner occupied housing. It is a well established fact that consumer price inflation significantly exacerbates the inefficiencies caused by the tax system.[17] This results from the considerable costs of introducing indexation in countries with more complex personal income tax systems. Without indexation, inflation changes the effective tax rate of different activities because taxes are levied in nominal terms rather than on real income. The more prominent effect discussed in the literature (see Feldstein (1999) and Dolado et al. (1999) for a review) of the inflation-taxation interaction is that inflation reduces the real net-of-tax return to corporate and household savings[18]. In addition, in countries where personal income tax schedules are progressive but not indexed, inflation may have a substantial negative impact on labour supply. For the US, Feldstein (1997) estimates that a reduction of long run inflation from 2% to 0% would imply a permanent increase in welfare of about 1% of GDP (in present discounted value terms, and using a discount rate of 5%, this amounts to a net welfare gain of as much as 29% of initial GDP[19] [20]). A very rough estimate of the welfare loss from the interaction of inflation and the tax systems in the euro area is provided in IMF (2002): a reduction of inflation from 2% to 1% could permanently increase welfare by 1%. On a present discount value basis (with a 3% discount rate), this would amount to a welfare gain by 17% of initial GDP. Available evidence for individual countries suggests that the estimated gains of moving from low inflation to price stability, are also substantial. Tödter and Ziebarth (1999) find that the welfare gain from reducing inflation by 2 percentage points was equivalent to a perpetuity of 1.4% of initial GDP.[21] For Spain, Dolado et al. (1999) find an even larger gain of 1.7% of initial GDP. However, for the UK the estimated effects are substantially lower (Bakhshi et al. (1999)).

### 2.2.4. Direct transaction costs from inflation

**i) Reduced consumer surplus from real balances (the so –called *shoe-leather* costs)**

A long tradition in economics (starting with Bailey (1956)) has approached the measurement of welfare costs from inflation by treating money as any other consumption good. As such, a positive nominal interest rate represents a tax on non-interest bearing money and causes welfare costs from losses in consumer's surplus from real balances.[22] The welfare costs of a positive interest rate in turn determine the welfare costs of inflation, since in steady state the former relates one-to-one with the latter (through the

[17] This is sometimes labelled the *Tanzi* effect.

[18] At the corporate level, inflation reduces the value of depreciation allowances, thereby increasing the effective tax rate. This in turn reduces the rate of return on corporate investments. As regards households, taxes levied on nominal capital gains and nominal interest also causes the effective tax rate to increase with the rate of inflation.

[19] This results from subtracting the one-off cost from disinflation –estimated at 6% of GDP- from the present discounted value of the gross welfare gain -estimated at 35% of initial GDP and resulting from discounting at the annual rate of 5.1% a permanent increase in welfare of 1% of initial GDP. See Feldstein (1999) for a detailed discussion.

[20] Further evidence of significant costs from the interaction of inflation and the tax system for the U.S. can be found in Bullard and Russell (1997).

[21] This results from the higher marginal taxes in Germany.

'Fisherian' equation). This aspect of the welfare cost from inflation in general equilibrium (which is often labelled as the "shoe-leather costs") has been often studied in isolation from other effects of inflation, and the distortion of other decision margins in the economy beyond the demand for real balances is not simultaneously considered.

There are two important implications from this approach for the welfare costs of inflation. First, it provides a clear-cut method to estimate a component of the welfare costs of inflation or interest rates (i.e. losses in consumers' surplus from real balances). Second, it ultimately leads to an (admittedly, incomplete) theory of the optimal rate of inflation and rate of interest in the economy (namely the so-called Friedman rule).

- Estimates of welfare costs of inflation from this approach. The large number of papers that have tackled this question tend to yield markedly different results. Some authors (e.g. Fischer (1981)) suggest that the "shoe-leather" gain in welfare (defined as the present discounted value of the permanent effect in output[23]) from a 10 percentage point reduction in inflation is as limited as 0.3% of GDP. In the other extreme, Gillman (1985) reports substantially larger figures (as high as 40% of initial GDP on present discounted value terms). More recent papers (e.g. Chadha et al (1998), Lucas (2000)) have stressed the large uncertainty surrounding measures of the consumers' surplus from real balances. In particular, it would seem almost impossible to know the magnitude of welfare losses of reducing nominal interest rate from a small figure to zero. This is for a number of reasons. First, as stressed in Lucas (2000), estimates seem largely dependent on the assumed functional form of the demand for real balances. Second, empirical evidence is characterised by the scarcity, if not the absence of observations for which nominal interest rates are in the neighbourhood of zero. Third, the demand for real balances is highly non-linear precisely in the neighbourhood of zero interest rate (see Stracca (2001)). This means that the question of whether there is consumer's satiation for real balances when the interest rate is zero is both crucial for the calculation and difficult to answer. Subject to all these caveats, Chadha et al (1998) suggest that the welfare gain from reducing inflation from 4% to 0% in the UK amounts to a permanent increase of 0.22% in output (a net welfare gain of around 9% of initial GDP in present discounted value terms when using a discount rate of 5%). This is well above previous estimates (e.g. Fischer (1981) and McCallum (1989)).[24]

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[22] That is, the area between the demand for real balances and the opportunity cost of holding non-interest-bearing deposits, i.e. the prevailing interest rate.

[23] The net welfare effect of a reduction in inflation is interpreted as the lump-sum transfer (as a percentage of initial GDP) that the representative agent would need to receive in a steady state with high inflation in order to be indifferent to the situation of a steady state with lower inflation (see Lucas (2000) for a more formal definition).

[24] It should be noted that all these studies treat money as a regular commodity. However, as the search-theory based models of money show (e.g. Trejos and Wright (1995)), there is a fundamental network externality in the demand for fiat money (i.e. each agent's demand for money depends on the willingness to accept money as a medium of exchange by all other agents). Introducing this important principle in the analysis of welfare cost of inflation could significantly alter the results.

- Derivation of the welfare maximising rate of inflation. The first application of this approach to the derivation of an optimal rate of inflation and interest rates is Friedman (1969), which puts forward the well known Friedman rule. The Friedman rule boils down to the idea that, to avoid any social waist in economising on real balances, nominal interest rates should be brought down to zero. This implies in particular that the optimal rate of inflation is a constant but moderate rate of price *deflation*. Phelps (1973) introduces one important caveat to the Friedman rule: inflation seignorage is one more tax in the economy and as such the optimal rate of inflation should be subject to public finance principles of optimal taxation. Chari et al (1996) shows that the resolution of the Friedman-Phelps controversy ultimately hinges on the magnitude of the income elasticity of money demand. In particular, barring other considerations (e.g. other distortions of inflation in general equilibrium), if the income elasticity of money demand is above one (which implies that taxing money –seignorage- is relatively distortive), inflation should be as low as possible and the Friedman rule obtains. In contrast, when the income elasticity of money demand is below 1 (which implies that taxing money –seignorage- is relatively innocuous for welfare) then it is efficient to set the interest rate (and, possibly, inflation) above zero. Furthermore, Correia and Teles (1999)[25] substantially strengthen the case for the Friedman rule by showing that the conditions under which the Friedman rule is optimal are considerably more general than those established by Chari et al (1996). [26]

**ii) Over-development of the financial system**

A very related but distinct welfare loss due to positive inflation relates to the economic resources that are allocated to the financial sector in order to accommodate the increased number of transactions chosen by households as they attempt to reduce the cost of holding currency. For instance, in order to satisfy increased customer activity under higher inflation, banks may need to hire additional tellers, build more and larger branches, etc. Such "over-development" of the financial sector entails a welfare loss because these resources are seen as inefficient investments, oriented to minimising the effects of higher transaction costs inflation, and are distracted from potentially more productive uses. A number of researchers have estimated the magnitude of the welfare loss due to an inefficient over-development of the financial system. English (1999) analyses the fraction of the financial system in GDP in a panel of OECD countries. He concludes that the effect of inflation, *ceteris paribus* (i.e. controlling for a number of

[25] See also De Fiore (2000) for the case when tax levying costs are present.

[26] The more recent research has analysed the robustness of the Friedman rule in more general settings. A branch of this more recent literature has focused on its robustness when the social planner is unable to commit to future outcomes. Results in this respect seem mixed: Rankin (2001) suggests that if the social planner is limited to operate under discretion, the Friedman rule does not obtain in equilibrium. Alvarez et al. (2001) finds that the Friedman rule obtains also under discretion in empirically relevant ranges of the parameters. A second line of research has analysed the optimal level and volatility of inflation when both monetary and fiscal policies are set optimally. Results differ markedly depending on whether nominal price rigidities are considered. Within this strand of research Chari et al (1991) in a DGEM model with perfect competition and flexible prices find a relatively high level of optimal volatility of inflation, a result which is confirmed in Schmitt-Grohe and Uribe (2001a) with imperfect competition and flexible prices. By contrast, Schmitt-Grohe and Uribe (2001b) and Benigno and Woodford (2003) show that a very small degree of nominal rigidities suffices to reverse the previous result and obtain a relatively very low degree for optimal inflation volatility for empirically plausible degrees of nominal rigidity.

relevant factors like per capita GDP) on the size of the financial system is significant, both economically and statistically. Furthermore, he finds that the related welfare cost of an increase in the inflation rate from 0% to 10% could be, in present discounted value terms, about 1¼% of GDP. Dotsey and Ireland (1996) estimate that a 10% increase in the rate of inflation (relative to a zero inflation benchmark) has welfare costs in the range of 1% to 2% of GDP. At the high end of estimates, Lacker and Schreft (1996) find that the cost of an inflation rate of 10% could amount to as much as 4% of GDP.[27]

**iii) Comprehensive account of the costs of inflation**

The costs of inflation described in the previous two sub-sections correspond only to what might be labelled the *direct* costs of inflation (i.e. in terms of losses in consumer surplus from real balances and inefficient over-development of the financial sector). However, these estimates could differ substantially once all the effects of inflation on the economy (e.g. distortion in labour supply, in savings decision, etc.) are simultaneously taken into account in a general equilibrium setting. Only recent research has tackled this question. Dotsey and Ireland (1996) calibrate a dynamic general equilibrium model (DGEM) where money enters in a cash-in-advance constraint, and where agents can produce financial services as an alternative to money to make transactions. In this setting, inflation is costly because (in addition of having direct costs in terms of reduced consumer surplus from real money balances) it distorts a number of decision margins. This induces agents to inefficiently invest in the production of financial services –i.e. as in the previous sub-section. In addition, distortions from inflation discourage agents' dedication to market activities relative to leisure. The authors find that the effect of sustained inflation on steady state growth is significant albeit limited. However, and importantly, they find that in their general equilibrium setting sustained inflation has an overall impact on total welfare that is considerably higher than what partial equilibrium estimates would suggest. Specifically, they calculate that a sustained increase in inflation from 0% to 4% would imply a permanent decline in the level of output in the range of 0.4% to 1.1%. A sustained increase in inflation from 0% to 10% would imply a permanent decline in output in the range of 0.9% to 2.2%. This is substantially higher than the partial equilibrium-based estimates (e.g. Fischer (1981) and Lucas (1981)).

Khan et al (2000) derive optimal monetary policy and the optimal rate of inflation in a dynamic general equilibrium model where inflation introduces two types of distortions[28]: those related to nominal lock-in (i.e. as in subsection 2.2.2. ii)) and those related to a direct cost of holding money (i.e. as in sub-section 2.2.5.i)). In their model, which is calibrated for the US economy, the optimal rate of inflation is close to zero and the role of optimal monetary policy (leaving out second order effects) is to stabilise the price level around trend.

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[27] English (1999) provides more informal information on welfare costs under very high rates of inflation and hyperinflation and suggests that in such cases the welfare cost of inflation from an over-expansion of the financial system could be proportionally much higher.

[28] There are other distortions relative to frictionless economy in their model (e.g. imperfect competition), but they are not a consequence of a positive rate of inflation).

Taking a more general perspective, Goodfriend and King (2001) argue that, in a New Neo-classical Synthesis setting characterised by imperfect competition and price and wage nominal rigidities, in which inflation introduces a number of distortions, price stability would provide a good approximation to the optimal monetary policy. Intuitively, price stability minimises the need to undertake price changes for the average firm, thereby getting close to minimising the distortion from inflation in the presence of nominal rigidities.

#### 2.2.5. Income redistribution

In the absence of inflation-indexed contracts (which are costly to implement) both inflation and deflation change the wealth distributions by generating transfers between nominal creditors and nominal debtors. This *per se* does not necessarily amount to a welfare loss but to a simple re-distribution of welfare. But, as pointed out by Issing (2001), there are certain aspects to this transfer of wealth that may have important real effects. For example, there may be a transfer of wealth from the less risk averse to the more risk averse, or from the young to the old. On a different level, in an environment of high inflation, the reduction in the real value of the nominal debt may very well act as a deterrent for lenders to supply credit. Furthermore, re-distributive effects of inflation are likely to make the distribution of wealth more uneven. Some authors (e.g. Erosa and Ventura (2001)) have shown analytically and empirically that inflation acts like a regressive consumption tax and find important distributional consequences for the case of the U.S.

## 3. Potential benefits of positive inflation

### 3.1 Nominal downward rigidities

A long standing debate starting with Tobin (1972) on the empirical relevance of nominal downward rigidities in prices and/or wages has recently gained momentum in the context of the lower average inflation rates seen in industrial countries in the last years. This is of direct interest for monetary policy, particularly for underpinning the optimal range for the inflation target, since nominal downward rigidities, if prevalent, could in principle hamper the functioning of monetary policy if the central bank aims for zero inflation.[29]

However, this debate is hampered by a number of difficulties, both at the conceptual and empirical levels. It may therefore be useful to look in some detail into each of the more important elements of the arguments put forward to form a balanced assessment of the relevance of downward nominal rigidities for the optimal rate of inflation. Fortunately this literature is making substantial progress in recent years and hopefully some of these issues will be clearer in a near future.

[29] This is for obvious reasons: under a negative demand or positive productivity shock nominal downward rigidities prevent the needed decline in prices or wages implying the emergence of persistent imbalances.

First, it would be important to get clear conceptual foundations for the presence of downward nominal rigidities. This would allow addressing questions like: Should rigidities be expected to be the same upon different types of shocks faced by the firm and the worker (e.g. productivity, vs. demand shocks; individual vs. aggregate shocks)? Do downward nominal rigidities refer to hourly wage rates or total nominal employees' income (e.g. independently of hours worked)? How are such downward rigidities affected by the degree of unionisation of the plant/firm or other institutional factors? Would rigidities vary with characteristics of the employment relationship (e.g. tenured vs. temporary workers; 'white' vs. 'blue collar' workers, etc.)?

Second, observable microeconomic implications would need to be extracted from the conceptual framework. Here the main problem is to distinguish between the presence of what can be labelled *exogenous* downward nominal rigidities (i.e. related to behavioural factors like money illusion or fairness considerations) and purely economic factors that may also tend to limit the variability of compensation related variables in the vicinity of zero inflation. For instance, even the if employment relationship were primarily governed by (implicit) long-term relations aimed at providing insurance and long-term career incentives to the worker, it could still be true that short-term changes in workers' compensation exhibit asymmetries around zero inflation. However, in this case such asymmetries would be reflecting equilibrium behaviour, rather than an intrinsic difficulty in or resistance to reductions in nominal wages.

Thirdly, to assess the importance of such rigidities for firms and the economy, the more relevant concept is likely to be the rigidity of total unit labour costs and not wages *per se*. Even in the presence of downward nominal rigidities in contractual wages, the firm might be able to attain labour cost flexibility in a low inflation environment, for instance if productivity growth does not falter or if workers' earnings incorporate some flexible components (bonuses, overtime, etc.). Furthermore, it is also of interest to assess the effects of downward rigidity in compensation related variables against the background of the overall flexibility of firm-worker relations. For instance, if a firm is constrained not to reduce the nominal hourly wage from the previous value but it has full flexibility to adjust the total number of hours hired, it may be able to fully circumvent such restriction in many practical respects (e.g. realised profits).

Fourthly, some further progress on the implications for structural, economic and monetary policies, consistently with the stance taken on the previous issues is still needed, particularly regarding the effects of policy measures on the continuation or dissipation of downward nominal rigidities. Finally, it is also important to study the likely implications of EMU for the future evolution of downward nominal rigidities.

The rest of this section takes stock on the state of the debate on downward rigidities on the basis of the five elements listed above. Table 1 provides a summary of the leading recent papers in this area. The contributions with respect to the first three elements mentioned above are particularly highlighted.

**Table 1: Summary of selected papers on downward nominal rigidities**

| Paper and country | Conceptual framework | Microeconomic evidence | Macroeconomic effects |
|---|---|---|---|
| Altonji and Deveraux (1999)<br><br>U.S. | Full-rationality micro model (based on MacLeod and Malcolmson (1993)) | Substantial degree of rigidity: reductions in nominal compensation are rare for salaried workers. | Inconclusive. Workers supposedly enjoying higher income due to downward nominal rigidities are not less likely to quit the firm. |
| Lebow, Sacks and Wilson (1999)<br><br>U.S. | Ad hoc: analysis of distribution of y-o-y changes in: 1) hourly wages and 2) benefits. | Substantial degree of rigidity: only about 50% of workers "expected" (from the model) to see a wage cut actually suffer it. | Limited (*micro-macro puzzle*): reducing average inflation from 4% to 2% reduces the rate of unemployment by about 0.4 p.p. |
| Akerloff, Dickens and Perry (2000)<br><br>U.S. | Bounded-rationality framework. Elements: workers are motivated by relative wages (work harder if they are paid more than in other companies). For low rates of inflation, some workers tend to underestimate the effect of inflation on other companies' wages. | Not provided. | Long-run inflation unemployment trade-off. Optimal inflation rate is about 2.2%. |
| Fehr and Goette (2000)<br><br>Switzerland | Ad hoc: analysis of distribution of y-o-y changes in: 1) fixed wage component in full compensation; 2) full compensation (hours treated as exogenous error term). | Substantial degree of rigidity: about 50% of all workers found to be affected by downward nominal rigidities.<br>Evidence of rigidities markedly different for workers with different contracts. | Effect of downward nominal rigidities on unemployment significant and systematic across regions and sectors but limited in magnitude (always lower than one percentage point.) |
| Knopikk and Beissinger (2003)<br><br>Germany | Ad hoc: analysis of distribution of y-o-y changes in total compensation (hours treated as exogenous error term), for workers in age range 25-65. | An overwhelming majority of workers found to have binding downward nominal rigidities. | Limited macro implications. For inflation rates in the range of 1% to 2% the effect of such rigidities on the rate of unemployment found to be about 0.4 p.p. |
| Farès and Lemieux (2001)<br><br>Canadian provinces | Sample 1: Ad hoc: effects of low inflation on 'real wages Phillips curve'.<br>Sample 2: Ad hoc: effects of low inflation on individuals' real wages. | Sample 2: Irrespective of the inflation rate, new entrants seem to bear a disproportionately share of the adjustments in real wages. | Sample 1:<br>Downward rigidities bind for a subset of workers (older and more senior workers) and seem to have only a modest impact on aggregate wages and employment.<br>'Provincial real wage Phillips curves' did not become flatter in years of low inflation. |

**Table 1 (continued): Summary of selected papers on downward nominal rigidities**

| Paper and country | Conceptual framework | Microeconomic evidence | Macroeconomic effects |
|---|---|---|---|
| Decressin and Decressin (2002)<br><br>Germany | Ad hoc: analysis of distribution of y-o-y changes in wages. | Substantial degree of rigidity, but similar to estimates seen for the U.S., rather than higher. | Not discernible macroeconomic effects. |
| Dessy (2002)<br>EU countries | Ad hoc: analysis of distribution of y-o-y changes in total labour earnings. | Significant evidence of downward rigidities but frequent instances of nominal wage reductions. Extent of downward rigidities not greater than for the U.S. | Not derived. |
| Annex II in this note<br><br>OECD countries | Ad hoc: effects of low inflation on 'real unit labour costs Phillips curve'. | | Real unit labour cost Phillips curves not affected by lower inflation. |

1. As regards the conceptual foundations of downward nominal rigidities, there seem to be little consensus among authors and some of the elements that underlie proposed views remain still in an early stage of scientific development. Some authors point out that standard principles of economic rationality would not be compatible with the possibility of persistent nominal downward rigidities, which would result primarily from alternative (and less well understood) psychological or behavioural mechanisms, like "money illusion" or the so-called loss-aversion paradigm[30] (on this issues Yates (1998) provides a comprehensive discussion). Some authors (e.g. Bewley (1997)) see the roots of downward rigidities in workers' fairness concerns (e.g. nominal wage cuts are seen as demeaning by workers). Finally, some papers provide a fully rational basis for downward rigidities. In particular, McLeod and Malcolmson (1993) argue that if wages are determined by periodic bargaining and the outside options for agents (i.e. their pay-off when rejecting to bargain) cannot be indexed to inflation then downward nominal rigidities would emerge in equilibrium as a fully rational phenomenon.

2. As regards available evidence on the presence in the past and possible persistence in the future of downward nominal rigidities, this has recently been addressed by a considerable number of articles, most of which find that a substantial proportion of wages are restricted by downward nominal rigidities.

   - Unfortunately limitations in data availability seem to be an important obstacle to the analysis of nominal downward rigidities. For example the scarcity of data from protracted periods with price

[30] Akerlof et. al (2000) also considers near-rational behaviour to justify the presence of grease effects.

stability or very low inflation forces researchers to infer the implications of a regime of permanently low inflation from observed behaviour within a regime of temporarily low inflation. An additional challenge has been to empirically disentangle the relative importance of asymmetric rigidities stemming from resistance to nominal wage cuts (i.e. downward nominal rigidities) from symmetric rigidities stemming from *menu costs* of revising nominal variables.

- The approach taken in the majority of these papers has been to start by postulating a number of plausible features of the distribution of the changes (usually year-on-year) in observable elements of workers' labour compensation. Such features are then seen as evidence of downward nominal rigidities in a broad sense (i.e. without asserting the nature or cause of such rigidities). In intuitive terms, this approach entails analysing whether there are "too few" data points corresponding to negative nominal changes in the distribution of changes in compensation, relative to a symmetric distribution. In addition, authors analyse whether declines in the inflation rate tend to increase the extent of such asymmetry in the distribution of compensation changes.

- Most authors find substantial evidence for downward rigidities (although for the case of Germany there are some discrepancies across authors –e.g. while Knopikk and Beisinger (2003) find overwhelming evidence of downward rigidity in German labour markets, Decressin and Decressin (2002) find more limited evidence). In a recent study Dessy (2002), finds evidence of nominal (but not real) wage rigidities in 12 European countries by analysing yearly wage changes in a sample of individual wage earners between 1994-96. Specifically, this paper presents descriptive evidence of nominal wage change distributions and finds that a significant share of full-time workers report zero wage change between consecutive years, indicating the presence of nominal wage rigidities for this type of workers. However, Dessy (2002) also finds that wage cuts are relatively common. Differences across countries appear to be considerable. A larger share of workers is affected by wage rigidity in Germany, Belgium and Italy, while a smaller share is affected in Spain and Ireland. However, given the preliminary nature of the results, the possible 'selection' bias due to the focus on specific worker categories (mainly full-time workers) and the lack of statistical control for macroeconomics conditions (such as the contemporaneous annual rate of inflation) or measurement error in the data, this evidence is inconclusive about the extent and consequences of nominal downward wage rigidity in Europe.

- A common thread across studies is that the stringency of such restrictions varies considerably with the characteristics of the worker (e.g. permanent and full time workers exhibit more rigidity that fixed-term and part-time workers; workers in manufacturing exhibit more rigidity than in services). This suggests that institutional features of the employment relationship may have a bearing on the emergence of such rigidities.

- Interestingly, when considering the extent of downward wage rigidities it is generally found that downward nominal rigidity in variable components of compensation (additional non-wage incentives) is considerably smaller than in the wage component. This supports the view that variable components in labour compensation would soften downward nominal restrictions.

Furthermore, some studies document that workers accept nominal cuts in the wage component when they shift from a fixed wage compensation to a compensation system that embodies both fixed but also variable components (i.e. incentives' oriented). This would suggest that the overall stringency of downward nominal rigidities may tend to decline over time as proportionally more workers see their labour income determined on the basis of performance-based systems, as according to some experts is the case (see Lebow (1999) for the US and Aghion et al. (1999) for European countries).

- Finally, none of these studies has been able to formally test whether measured downward nominal rigidities result from "rational" considerations or "money illusion" (which of course is not easy, given remark 1 above).

3. As regards the assessment of the extent to which downward nominal rigidities have discernible macroeconomic effects, authors have taken two main approaches. First, to extract a counterfactual distribution of wages that could have resulted without rigidities and infer the respective (counterfactual) unemployment rate, which is compared to the actual unemployment rate. Second, to estimate the effects of very low inflation rates on a standard or modified Phillips curve.

   - As regards the first approach, most studies seem to coincide in finding that such effects are limited (particularly in the case of the U.S.), in spite of the fact that the latter seem pervasive. This has led to some authors to talk of a *micro-macro puzzle*, that is, the surprising result that such a widespread phenomenon like downward rigidities has apparently a limited aggregate impact. In this respect, some authors (e.g. Altonji and Deveraux (1999) and Lebow et al. (1999)) argue that firms possibly foresee the effects of nominal downward rigidities and thus set up ex ante the wage policy of the firm so as to "sterilise" ex post such effects (e.g. by setting 'low' – below productivity- wages at the point of entry in the firm, so that workers 'pay' up front in their career the potential future rents derived from downward rigidity

   - As regards the second approach (i.e. analysing the effect of low inflation rates on the slope of the Phillips curve), the degree of consensus in the results seems to be relatively small. Akerlof, Dickens and Perry (2000) argue that average inflation rate in the range of 2% to 3% would reduce the long term unemployment rate by 2 percentage points (p.p.) relative to the case with zero average inflation. By contrast, for the case of Canada Farès and Lemieux (2001) find that lower inflation had no impact on real wage adjustment, which rejects the view that downward nominal rigidity is binding (since otherwise very low inflation would increase the sluggishness of real wage adjustment). For European countries some very tentative evidence is available in Wyplosz (2000) and Dickens (2000). The results of these studies refer only to a limited number of countries and are overall very tentative. As stated in Dickens (2000), available results at this stage "do not make an iron clad case against the ECB's target range for inflation of 0 to 2% but they should give the ECB reason for concern". Using an approach similar to Farès and Lemieux (2001), Annex I shows that for a sample of OECD countries, inflation rates below 2% have no impact on the adjustment of real unit labour costs (i.e. downward nominal rigidities are not found

to affect the adjustment of real unit labour costs relative to unemployment). By contrast, Annex I shows that some institutional characteristics of the labour impact have a significant impact on the sluggishness of the adjustment process.

4. As regards the derivation of policy implications, consensus among authors seems particularly limited. While some authors refrain from drawing policy implications, possibly as a consequence of the preliminary state of the discussion (e.g. Altonji and Deveraux (1999), Lebow et al. (1999)) others argue that, based only on considerations from downward nominal rigidities, average inflation should be in the range of 2% to 3% in the U.S. (Akerloff et al. (2000)) or higher than 3% in Germany (Knopikk and Beissinger (2003)) to minimise the long-term NAIRU.

   However tentative the results may be and in the light of the still very preliminary state of the debate it seems crucial to bear in mind a few potentially important considerations for the discussion on desirable policies:

   - Whatever the ultimate source of downward rigidities, it would seem that they are not everywhere and every time a deep rooted phenomenon. Rather, specific labour market institutions seem to favour the emergence or strengthen the effects of such rigidities. This suggests that the existence of downward nominal rigidities themselves should not necessarily be taken as given and could be seen as one objective for structural economic policies.

   - The evidence discussed above and also historical evidence.[31] suggests that downward nominal rigidity is an undesirable feature of labour relations. Thus, arguments weighting any possible shorter term gains from monetary policy accommodating such rigidities (e.g. by deliberately increasing average inflation rates) must take into account the effects of accommodating and perhaps entrenching them in the longer term.

   - From a more general perspective, if certain psychological or behavioural factors like money illusion were going to be explicitly taken as an important consideration, it could be difficult to establish a clear-cut welfare criterion to assess policy outcomes. Should the welfare criterion represent the money illusion in agents' preferences, or should money illusion be ignored for such calculations (i.e. social welfare not aggregating consumers' preferences but modified versions of it) and welfare be conventionally defined in terms of real variables (e.g. consumption and leisure)? Furthermore, even if it were deemed appropriate that economic policies should be calibrated to take into account the existence of money illusion on the part of the public, it is not clear which implications this would have in terms of desirable rates of inflation.[32]

[31] Some authors (e.g. Cole et al. (2002)) have recently argued that downward nominal rigidities strengthened deflationary forces in the Great Depression in the U.S. and European countries. Conversely, downward nominal flexibility has possibly contributed to limit the destabilising impact from deflation and close-to-zero nominal interest rates in the last years.

[32] In this connection, the survey in Howitt (2002) suggests that the presence of money illusion could be a compelling argument favouring the case for price stability.

5. Finally, Monetary unification in Europe is a fundamental regime shift likely to trigger over the longer term transformations in patterns of price and wage setting. From a macroeconomic point of view, there seem to be some consensus in the literature on the fact that EMU will probably tend to increase the demand for nominal wage flexibility in labour contracts, related to the need for alternative adjustment mechanisms (given the absence of country specific monetary policy under EMU) following idiosyncratic shocks (see Bertola (2001), Calmfors (2002) and references therein).[33] A potentially important impact effect of EMU, that would work through increased market competition in the euro area, could be the potential decline in the degree of centralisation of collective bargaining at the country level. The fact that excessive wage increases in the tradable sector would become more strongly 'punished' by the market under a monetary union may reduce the incentives to co-ordinate and centralise wage negotiations, thus possibly leading to a somewhat more informal co-ordination of wage settings (see Boeri *et al* (2001)). However, evidence in this respect is still scant, as most of the available empirical evidence refers to the ERM years. Specifically, Eichengreen (1998) reports the absence of significant increase in nominal wage flexibility in the European countries after joining the ERM.[34]

A final caveat that should be mentioned in this context relates to the strict focus of these on the potential distortions arising from nominal downward rigidities in prices and labour compensation. Obviously, any advice from these papers on the optimal rate of inflation should be taken with due caution, as the required analysis regarding the optimal inflation rate should necessarily encompass and carefully weight the implications from all relevant considerations, not least the direct costs from departing from price stability reviewed in Section 2 of this paper.

## 3.2 Downward nominal rigidities and inflation differences within the euro area

Ever since the project of the economic and monetary union in Europe moved into its decisive phase in the second half of the 1990s, there has been an intensive debate on the effects of a common monetary policy in an area with potentially diverging economic developments and different economic structures across regions and countries. In this respect, some researches and policy makers had questioned whether "one size fits all" in terms of conducting monetary policy will be ultimately feasible. Related to this debate is the notion that large and persistent cross-country inflation differentials might complicate the conduct of a common monetary policy in Europe. Inflation differentials may affect competitiveness of countries participating in a currency union, and exchange rate adjustments can no longer be used to compensate for potential losses in competitiveness.

[33] Another factor contributing to higher nominal wage flexibility is deunionisation in most European countries as reported in Ebbinghaus and Visser (2000) and Calmfors et al.(2001), who show that average union density in Western Europe has declined from 44 percent in 1979 to 32 percent in 1998.

[34] Related to this, Calmfors (1998), and Calmfors *et al*. (2001, Ch. 4) examine the actual experiences in the 1980s and 1990s of Austria, Belgium, France and the Netherlands, the countries with the more consistently performing hard-currency policies in the ERM, and do not find instances of aggregate nominal wage reductions even in years with very high unemployment. The Netherlands however provides an example of nominal wage cuts in the public sector after the Wassenaar agreement in 1982.

To assess the relevance of inflation differentials for the optimal rate of inflation in the euro area, it seems crucial to carefully consider the sources of potential inflation differentials across countries.[35] In addition, it would be necessary to clarify which aspects of inflation differentials reflect equilibrium phenomena (for which economic policy action may not be required), which aspects reflect imbalances that would in principle call for national remedies and, finally, which aspects could pose challenges for conducing monetary policy.

Relating such analysis of the sources of inflation differentials, the available evidence (IMF (2002)) indicates that a number of structural factors can account for a significant fraction of the observed inflation differentials across euro area countries: *inter alia*, the tendency towards convergence in price levels, the so-called Balassa-Samuelson effect and other structural factors related to real convergence across euro area countries (e.g. changes in sectoral composition, shifts in labour participation rates). Given available evidence, it would be difficult to gauge the relative contribution of these factors in explaining current and future euro area inflation dispersion at this stage.

As regards the contribution of differences in countries' price levels to inflation differentials, a recent paper (Rogers (2002)) estimates that the contribution of price level dispersion in 1999 to observed annual HICP inflation dispersion at the end of 2002 was in the range of 12% to 31%. Moreover, this study argues that since euro area countries seem to have achieved already by 1999 a level of price level convergence similar to that of US regions, the effect of price level convergence on countries' inflation dispersion should be considerably weaker in the coming years, relative to the estimates for 2002.[36]

As regards the role of the Balassa-Samuelson effect (B-S henceforth) in explaining inflation differentials, a number of recent studies[37] have attempted to gauge its magnitude. Overall, these studies suggest that the B-S effect would imply sustained and non-negligible inflation differentials in euro area countries. Taken together, these studies would suggest that, as a result of the B-S effect, the spread in average inflation between the lowest average inflation country (which in all studies corresponds to Germany) and the highest average inflation country could be in the range of 1.1 to 2.4 percentage points.

Table 2 summarises existing estimates of the Balassa-Samuelson effect in euro area countries.[38] (Comparability across studies is hindered by differences in considered sample periods and methodologies). To facilitate comparability, average euro area inflation is normalised to 1.5%.

All estimates in Table 2 are broadly in line as regards overall dispersion (last two rows), except perhaps the ones in Sinn-Reuter (2000).[39] However, looking at individual countries, wider discrepancy between

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[35] For a very enlightening discussion see Blanchard (2000).

[36] See also ECB (2002).

[37] Alberola and Tyrväinen (1998), Canzoneri et al. (1998), De Grauwe et al. (2000) and Sinn and Reuter (2001). See also IMF (2002) for a broader discussion.

[38] For background information on actual average inflation differentials in euro area countries see Annex II.

[39] The results in Sinn and Reuter (2001) would seem to overestimate the Balassa-Samuelson effect and indeed they suggest a very high degree of dispersion compared to the other studies (but sample differences make this comparison difficult). Moreover, it suggests a very high HICP inflation rate in Greece as a result of the BS effect, (i.e. slightly above of what is seen even under the recent period of strong price increases).

estimates emerges, reflecting a high degree of uncertainty surrounding the size of BS effects. Taken at face value, these estimates[40] suggest that the BS effect could by itself explain a considerable fraction of observed differentials. However, given the high degree of uncertainty surrounding estimates (stemming also from methodological shortcomings -e.g. the fact that few of these studies consider a comprehensive analysis of inflation differentials), a high degree of caution in the assessment of these results is needed.

**Table 2:**

**Inflation differentials in the euro area arising from B-S effect**

| | Canzoneri et al. | Alberola and Tyrvainen | Sinn - Reutter | De Grauwe - Skudelny | IMF |
|---|---|---|---|---|---|
| | 2000 | 1998 | 2001 | 2000 | 2002 |
| Sample Years | (1973-1997) | (1975-1995) | (1987-1995) | (1987-1995) | (1995-2001) |
| Belgium | 2.1 | 2.6 | 1.4 | 1.6 | 1.5 |
| Germany | 0.5 | 0.8 | 0.6 | 1.2 | 1.4 |
| Greece | - | - | 4.7 | - | 2.2 |
| Spain | 1.9 | 2.6 | 2.1 | 1.5 | 1.8 |
| France | 1.9 | 1.2 | 1.9 | 1.1 | 1.4 |
| Ireland | - | - | 2.9 | - | 2.9 |
| Italy | 2.3 | 1.9 | 2.1 | 1.9 | 1.4 |
| Netherlands | - | 1.8 | 2.0 | 1.5 | 1.8 |
| Austria | 1.3 | 1.3 | 2.0 | 2.0 | 2.0 |
| Portugal | - | - | 1.4 | 1.6 | 2.2 |
| Finland | 1.9 | 1.9 | 3.3 | 0.9 | 1.8 |
| Max-Min | 1.8 | 1.8 | 4.1 | 1.1 | 1.5 |
| Dispersion | 0.6 | 0.6 | 1.1 | 0.4 | 0.5 |

*Note: Euro area inflation has been normalised to 1.5% to facilitate comparability across studies.*

A more general approach to explaining inflation differentials through the Balassa-Samuelson hypothesis attempts to assess the extent to which different factors (including changes in mark-ups, labour costs and

[40] To the extent that real convergence among current member countries implies a gradual diminishing impact of the BS effect, the estimates in Table 2 might be subject to an upward bias. Therefore these estimates should be regarded as representing a rather pessimistic view of the potential size of BS effects in those countries.

labour productivity) contribute to explain the observed changes in inflation in tradable and non-tradable goods prices. This approach has been implemented by Canzoneri *et al* (1999) for the OECD countries and by Ortega (2003) for the four larger euro area countries. These authors examine in particular whether the effect of changes in relative productivity is, as the Balassa-Samuelson hypothesis would suggest, predominant. If this were not the case, sustained inflation differentials would likely be, in this view, the result primarily of changes in the relative competitiveness of euro area economies. The result of the work for the euro area in Ortega (2003) shows that relative prices have moved in line with relative productivity over the long run as prescribed by the Balassa-Samuelson hypothesis. However, these results also show that the Balassa-Samuelson hypothesis fails to account for the whole amount of the inflation differentials in the main European economies in the years prior to 1999. Persistent changes in relative wages and the ratio of nominal unit labour costs to marginal labour productivity have also played a significant role.

Overall, the current assessment of overall factors impinging on sustained inflation differentials suggests in particular that the magnitude of the Balassa-Samuelson effect is plausibly limited and should be declining over time[41] (Rogoff, 1996). Beyond that, a reliable breakdown of the persistent component in inflation differentials according to the possible underlying causes is at the time not available.

To summarise, there is little question that some inflation differentials across euro area countries will persist as long as real convergence continues to progress. However, there is a strong case to argue that such inflation differentials should be seen primarily as an equilibrium phenomenon, with little bearing on the conduct of monetary policy. Some recent research contributions support this claim. Duarte and Wolman (2003), in a two country dynamic general equilibrium model with tradable and non-tradable goods show that a calibrated distribution of structural productivity shocks can easily account for equilibrium inflation differentials of the magnitude seen in the euro area. Benigno (2003) and Benigno and Lopez-Salido (2002), in dynamic general equilibrium macromodels (DGEM) of a two-country currency union, show that (as long as inflation persistence is similar across currency union countries) optimal monetary policy (in their setting) can be expressed in terms of the inflation rate in the currency union alone, without regard for differences in countries' rate of inflation.[42]

Some experts have argued that the **combination** of sustained inflation differentials across euro area countries and the existence of nominal downward rigidities in prices and, particularly, wages (or more generally labour costs), could pose problems for the functioning of the single monetary policy. The logic of the argument would be:

- Sustained inflation differentials combined with the objective of euro area HICP inflation below 2% implies that the lower inflation countries (i.e. those with a higher income per capita) exhibit "very low" inflation rates. That is, if average euro area HICP inflation is, say, 1.5% and due to structural

[42] The results of course reverses if countries exhibit different degrees of inflation persistence. The point is that in their framework inflation differentials arising from the B-S effect do not inform optimal monetary policy.

reasons a number of countries have significantly higher average inflation than others, then the average inflation of lower inflation countries would need to be below 1.5%.

- If nominal downward rigidities prevail, in particular in the lower inflation euro area countries, then these countries may have no margin to adjust downwards real labour costs upon a negative aggregate shock. This potential problem of lack of margin for adjustment would be particularly stringent in periods when productivity growth is low.
- An additional risk associated with some countries exhibiting close to zero inflation with some recurrence is the detrimental effect this could have on financial stability (e.g. if markets associate to this the possibility of deflationary spirals setting in) and the sustainability of fiscal positions (e.g. since the government debt level would be increased in real terms).

All in all, assessing whether lower inflation countries in the euro area may face these sort of risk of is difficult given the short history of EMU and since only very few studies have addressed specifically this question. The possibility of one region facing sustained deflation in a single region of a monetary union while the union as a whole enjoys price stability seems to be very unlikely. The main concerns with a situation of deflation are the risks of emergence of self-fulfilling deflationary expectations and eventually a liquidity trap. However, an episode of sustained deflation or even a deflation spiral in a region of the euro area seems to be unlikely. In a region within a monetary union which as a whole experiences price stability, the emergence of medium to long-term deflation expectations would tend to be offset by expectations of stronger aggregate demand, as deflation would have an immediate impact on the competitiveness of the region relative to the rest of the monetary union. As regards the risk of deflation for the euro area as a whole, the risk that the monetary authority would have to lower interest rates to zero and then be effectively constrained by the zero lower bound does not seem to be substantial for inflation objectives below but close to 2% per annum.

## 4. Conclusions

This paper has discussed some of the issues that should be taken into consideration in assessing the optimal rate of inflation, with a view to contributing to the debate on the desirable properties of the inflation process in the euro area. Two main lines of argument have been reviewed: the contributions assessing the costs of inflation (both in terms of long-term real GDP growth and economic welfare) and two elements related to the potential 'benefits' of small positive rates of inflation, namely the role of nominal downward rigidities in price and wage setting and the role of sustained inflation differentials across euro area countries.

Against this background, the main conclusions of the paper may be summarised as follows.

First, recent evidence confirms the presence of a negative and significant effect of inflation on long term growth, even at moderate rates of inflation. As regards the relative effects on long-term growth of high

average inflation versus high inflation volatility, recent structural analysis suggests that higher average inflation has a negative impact on growth and welfare, whereas higher inflation volatility has a negative impact on welfare and a likely negative, albeit quantitatively minor effect on growth.

Regarding the detrimental effects of average inflation on welfare, four main channels are reviewed.

1. On the interaction of inflation and the tax system, the latest evidence confirms that inflation considerably exacerbates the inefficiencies stemming from non-indexed tax systems, in particular in some European countries.

2. Regarding the effects of nominal rigidities two types are distinguished: i) menu costs (i.e., it is costly to change prices) and ii) nominal lock-in (i.e. it is not possible to change prices in a time interval). Recent work suggests that in the presence of symmetric nominal rigidities the optimal inflation rate is zero (to minimise the distortions of nominal rigidities on relative prices). However, precise estimates of the welfare costs of inflation stemming from nominal rigidities are not available and the risks associated with the zero lower bound on nominal interest rates are not taken into account.

3. As for the effects of inflation on income redistribution it is likely to be significant, but quantitative evidence is not available.

4. Regarding the direct costs from inflation, two types are distinguished:

   4.1. Reduced consumer surplus from real balances (so-called *shoe-leather* costs). Recent estimates suggest that these costs might be significant and possibly greater than what had been estimated in the past. Recent theoretical and empirical research focusing strictly on these considerations tends to give fairly strong support to the so-called Friedman rule (i.e. zero nominal interest rates, implying steady but moderate deflation).

   4.2. Excessive allocation of resources to the financial system: Recent empirical work based on international evidence would indicate that inflation induces the financial sector to grow beyond what would seem optimal. This work suggests that the welfare loss arising from such inefficient allocation of resources could be significant.

We have also briefly addressed those risks associated with deflation. The main concerns with a situation of sustained deflation are the risks of emergence of self-fulfilling deflationary expectations and eventually a liquidity trap, as well as the limitations a zero lower bound on interest rates entail for monetary policy. The possibility of episodes of sustained deflation or even a deflation spiral in a region of the euro area seems to be unlikely. In a region within a monetary union which as a whole experiences price stability the emergence of medium to long-term deflation expectations would tend to be offset by expectations of stronger aggregate demand. Deflation in one region would have an immediate positive impact on the competitiveness of the region relative to the rest of the monetary union. In a similar vein, the risks that monetary policy would have to lower interest rates to zero and then effectively be constrained by the zero lower bound in the euro area seems rather small for inflation objectives below but close to 2% per annum.

Overall, evidence suggests that even moderate rates of inflation are likely to entail significant welfare losses. Furthermore, the more recent work has tackled the measure of the welfare costs from inflation with superior, general equilibrium frameworks. In general, these superior estimates strengthen the case for price stability. As regards the potential benefits of inflation, the underlying arguments and the available evidence are relatively much less clear cut.

As regards, the simultaneous presence of nominal downward rigidities and inflation differentials in a monetary union, a conclusive answer is difficult to find. It is difficult either to confirm or dismiss their macroeconomic relevance, albeit the more recent evidence suggests, with few exceptions, that the macroeconomic effect of downward nominal rigidities is limited. Overall, the evidence indicates that such rigidities relate prominently to prevailing institutional features of the labour market. In this respect, it seems that the relevant issue is how structural policies could aim at preventing or eliminating them or even whether downward rigidities can be expected to gradually disappear in a low inflation regime, rather than whether or not the quantitative definition of price stability can ensure that downward nominal rigidities do not become binding (which could perhaps ultimately entrench such rigidities in labour markets).

All in all, taking also into account the evidence surveyed and provided in Yates (2003), Coenen (2003) and Klaeffling and Lopez (2003) on the factors impinging on the likelihood of nominal interest rates hitting the zero lower bound –an issue not addressed in detail in this paper- it would seem that the benefits of an inflation policy that tolerates a positive small average rate of inflation more than offset the direct costs of such rate of inflation. Those benefits would relate primarily to a reduced probability of nominal interest rate approaching the zero bound and the emergence of deflationary expectations. This suggests introducing a small safety margin in the price stability objective, which makes explicit that monetary policy would act to prevent that inflation trends do not come close to zero. Such small safety margin introduces an element of insurance against outcomes of a low probability but with potentially damaging effects. At the same time, taking into account the previous review of the evidence, the possibility of nominal downward rigidities being a relevant factor to determine such a safety margin seems considerably less clear, given that results in this respect across countries are markedly uneven and seem to depend strongly on institutional factors. In particular, one clear conclusion from the available evidence is that whenever flexible forms of contracting in labour markets are present, the macroeconomic relevance of nominal downward rigidities tends to vanish.

A more general consideration in this connection is how to determine the appropriate small safety margin for the price stability objective. In this respect, a misguided approach would be to estimate different sizes of such safety margin taking into account each time only one or a few of the relevant considerations (i.e. the zero lower bound for nominal interest rates, measurement bias in the HICP, nominal downward rigidities, etc.), and then add them up to find an overall safety margin. Such approach would obviously 'double-count' the benefits of an extra margin in the price stability objective. Instead, gauging the size of the appropriate safety margin requires a sound judgement of all the relevant factors simultaneously.

Moreover, it needs to be taken into account that a small safety margin above zero inflation permits to alleviate all those risks simultaneously. Finally, it should be kept in mind the strong evidence of the significant direct costs of inflation even for low rates of inflation.

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## ANNEX I: LOW INFLATION AND THE ADJUSTMENT OF REAL UNIT LABOUR COSTS IN OECD COUNTRIES.

This Annex analyses whether low inflation rates (below 2%) have any effects on the labour cost adjustment process, i.e. if low inflation hampers the adjustment process (e.g. due to downward nominal wage rigidities. This approach to gauge the relevance of downward nominal wage rigidities is similar to some approaches taken in the optimal inflation literature. Fares and T. Lemieux (2000) (cited above) estimates a real wage Phillips curve where it is tested whether the presence of low inflation rates hampers the adjustment process in the context of data for Canada. This annex broadly replicates this approach for a sample of OECD countries by considering the effect of low inflation rates on the slope of a real unit labour cost Phillips curve. The logic of the exercise is based on realising that downward nominal rigidities entail an increase in real wage rigidity as inflation becomes low.

Tables AI 1 and AI 2 show the panel-data results of an instrumental variables estimation where the year-on-year change in real unit labour costs is regressed on the rate of unemployment (decomposed by age and gender groups), institutional characteristics[43] (for Table AI 1) and regional dummies (for Table AI 2). In both cases instruments used are demographic variables and institutional characteristics.

The more salient implication of Tables AI 1 and AI 2 is that the interaction variable with the product of dummy for below 2% inflation and the aggregate unemployment rate is not significant. Thus, while a higher unemployment rate exerts downward pressure on real unit labour costs, the fact that inflation is below 2% does not seem to impinge on the adjustment process. However, the important caveats mentioned in section 3, that should be applied to available studies assessing the extent of downward nominal rigidities, should be applied also here. In particular, since the number of observations with low inflation in the sample is limited.

Results in Table AI 1 and Table AI 2 indicate that there is very little evidence that low inflation rates affect the real unit labour costs adjustment process. By contrast, Table AI 1 (which includes the institutional variables from Blanchard-Wolfers (2000)) suggests that structural reforms affecting the institutional design of labour markets could have a very considerable impact on the adjustment process.

[43] From the Blanchard-Wolfers (2000) data-base.

**Table AI 1: Real unit labour cost Phillips curve (1).**

| | | Coefficient | Std.Error | t-value | t-prob |
|---|---|---|---|---|---|
| Constant | Exogenous | 0.0461 | 0.0300 | 1.5400 | 0.1260 |
| Unemp. Rate, males, 15-24 years. | Endogenous | -3.9549 | 2.0550 | -1.9200 | 0.0550 |
| Unemp. Rate, males, 25-54 years. | Endogenous | -0.2577 | 2.1580 | -0.1190 | 0.9050 |
| Unemp. Rate, males, 55-64 years. | Endogenous | -3.4792 | 3.6770 | -0.9460 | 0.3450 |
| Unemp. Rate, females, 15-24 years. | Endogenous | 1.6378 | 1.4980 | 1.0900 | 0.2750 |
| Unemp. Rate, females, 25-54 years. | Endogenous | 0.5210 | 0.9288 | 0.5610 | 0.5750 |
| Unemp. Rate, females, 55-64 years. | Endogenous | 1.2365 | 2.9140 | 0.4240 | 0.6720 |
| Dummy, inflation rate below 2% | Endogenous | -4.5589 | 4.6410 | -0.9820 | 0.3270 |
| Dummy, inflation rate below 2% * aggregate unemployment rate | Endogenous | 3.6825 | 4.1260 | 0.8930 | 0.3730 |
| Dummy for period 1960-82 | Exogenous | -0.0091 | 0.0214 | -0.4270 | 0.6700 |
| Dummy for period 1983-92 | Exogenous | -0.0009 | 0.0120 | -0.0785 | 0.9370 |
| Replacement rate | Exogenous | 0.0003 | 0.0003 | 0.8790 | 0.3800 |
| Unemployment benefits | Exogenous | 0.0024 | 0.0031 | 0.7570 | 0.4490 |
| Active labour market policies | Exogenous | 0.0002 | 0.0003 | 0.6110 | 0.5420 |
| Union centralisation | Exogenous | -0.0001 | 0.0075 | -0.0131 | 0.9900 |
| Union density | Exogenous | 0.0007 | 0.0003 | 2.6700 | 0.0080 |
| Tax wedge | Exogenous | 0.0001 | 0.0003 | 0.4040 | 0.6860 |
| Coordination | Exogenous | 0.0188 | 0.0100 | 1.8900 | 0.0600 |
| Employment protection | Exogenous | 0.0009 | 0.0013 | 0.6650 | 0.5060 |

(no. of observations 402)

**Table AI 2: Real unit labour cost Phillips curve (2).**

| | | Coefficient | Std.Error | t-value | t-prob |
|---|---|---|---|---|---|
| Constant | Exogenous | 0.0058 | 0.0050 | 1.0200 | 0.3070 |
| Unemp. Rate, males, 15-24 years. | Endogenous | -2.3038 | 0.8250 | -2.7900 | 0.0060 |
| Unemp. Rate, males, 25-54 years. | Endogenous | 0.7857 | 0.6530 | 1.2000 | 0.2300 |
| Unemp. Rate, males, 55-64 years. | Endogenous | 0.1026 | 1.3640 | 0.0700 | 0.9400 |
| Unemp. Rate, females, 15-24 years. | Endogenous | 1.0432 | 0.7020 | 1.4800 | 0.1380 |
| Unemp. Rate, females, 25-54 years. | Endogenous | 0.3218 | 0.4680 | 0.6800 | 0.4930 |
| Unemp. Rate, females, 55-64 years. | Endogenous | -1.6632 | 1.4240 | -1.1700 | 0.2440 |
| Inflation below 2% interacted with aggregate unemplyment | Endogenous | 0.3174 | 0.8453 | 0.3750 | 0.7080 |
| Dummy for period 1960-82 | Exogenous | 0.0103 | 0.0080 | 1.2700 | 0.2050 |
| Dummy for period 1983-92 | Exogenous | -0.0117 | 0.0040 | 3.1300 | 0.0020 |
| Northern continental Europe | Exogenous | -0.0126 | 0.0050 | -2.4300 | 0.0150 |
| Southern continental Europe | Exogenous | -0.0015 | 0.0050 | -0.2800 | 0.7820 |
| Japan | Exogenous | -0.0115 | 0.0060 | -1.8100 | 0.0710 |
| Scandinavian countries | Exogenous | -0.0069 | 0.0050 | -1.4100 | 0.1590 |

(number of observations: 403)

## ANNEX II: OBSERVED AVERAGE INFLATION DIFFERENTIALS IN THE EURO AREA

Observed inflation differentials are summarised in Table AII, which presents normalised average annual HICP inflation rates in euro area countries, with average euro area inflation set equal to 1.5% (this normalisation is for comparability purposes). Table AII indicates a slight decline in dispersion when only EMU Stage Three years are included. (Sample availability is restricted by starting date of official headline HICP inflation at the country level). Observed inflation differentials may result from a number of factors could explain *inter alia*, differences in countries fiscal stance, differences in national government policies, other than fiscal (e.g. indirect tax and administrative price changes, product and labour markets regulatory frameworks, etc.), sectoral productivity differentials (e.g. in the tradable and non-tradable goods sectors, as formulated in the Balassa-Samuelson framework.[44]) and differences in cyclical positions between countries, which usually imply differences in inflation rates.

[44] See Balassa (1964) and Samuelson (1964).

**Table AII:**

**Observed inflation differentials in the euro area (HICP)**

| Sample years | (1996-2002) | (1999-2002) |
|---|---|---|
| Belgium | -0.1 | 0.0 |
| Germany | -0.4 | -0.4 |
| Greece | 2.8 | 1.0 |
| Spain | 0.8 | 0.8 |
| France | -0.4 | -0.5 |
| Ireland | 1.1 | 1.6 |
| Italy | 0.6 | 0.3 |
| Netherlands | 0.7 | 1.0 |
| Austria | -0.4 | -0.4 |
| Portugal | 0.9 | 1.0 |
| Finland | 0.0 | 0.2 |
| Average annual HICP inflation in euro area | 1.9 | 2.2 |
| Dispersion | 0.8 | 0.7 |

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