EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO. 521 / SEPTEMBER 2005

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In 2005 all ECB publications will feature a motif taken from the €50 banknote.

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1 *The views expressed in this paper are those of the authors and do not necessarily reflect those of the institutions to which they are affiliated. The authors gratefully acknowledge the considerable input from members of the Working Group of Econometric Modelling into the preparation of this paper, whilst retaining responsibility for all errors.*

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The Eurosystem Inflation Persistence Network

This paper reflects research conducted within the Inflation Persistence Network (IPN), a team of Eurosystem economists undertaking joint research on inflation persistence in the euro area and in its member countries. The research of the IPN combines theoretical and empirical analyses using three data sources: individual consumer and producer prices; surveys on firms' price-setting practices; aggregated sectoral, national and area-wide price indices. Patterns, causes and policy implications of inflation persistence are addressed.

Since June 2005 the IPN is chaired by Frank Smets; Stephen Cecchetti (Brandeis University), Jordi Galí (CREI, Universitat Pompeu Fabra) and Andrew Levin (Board of Governors of the Federal Reserve System) act as external consultants and Gonzalo Camba-Méndez as Secretary.

The refereeing process is co-ordinated by a team composed of Günter Coenen (Chairman), Stephen Cecchetti, Silvia Fabiani, Jordi Galí, Andrew Levin, and Gonzalo Camba-Méndez. The paper is released in order to make the results of IPN research generally available, in preliminary form, to encourage comments and suggestions prior to final publication. The views expressed in the paper are the author's own and do not necessarily reflect those of the Eurosystem.

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ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

CONTENTS

Abstract

This paper analyses the response of inflation in the euro area to five macroeconomic shocks through the use of results derived from Eurosystem large-scale macroeconomic models. The main finding is that only a fiscal shock, and to a lesser extent a TFP shock, generate marked inflation persistence. In contrast, an indirect tax and an oil price shock appear much less persistent and a social security shock generates less inflation persistence in the majority of the countries (although some weak persistence was observed at the euro area level). The paper also considers evidence on the sources of persistence, which indicates that it is crucially affected by the responsiveness of wages to employment, by the sluggishness in the adjustments of the demand components, and by the speed of adjustment of employment to output and wage changes.

Key Words: Inflation persistence, large-scale macroeconomic models, impulse response function.

JEL classification: C53, E31, E52

Non-technical summary

This paper analyses the response of inflation in the euro area to various macroeconomic shocks through the use of Eurosystem macroeconomic models. The paper contributes to the Eurosystem's Inflation Persistence Network (IPN), and the results reported in the paper have been produced in collaboration with the Working Group on Econometric Modelling (WGEM). The IPN studies inflation persistence from a variety of angles, such as micro-data, surveys on price-setting behaviour, time series models, and DSGE models. The present paper adds to the existing literature for the following reasons.

First, since the paper utilises information coming from national models maintained by the National Central Banks (NCBs) of the Eurosystem, it makes use of models that are actually used in policy-making. Second, NCBs macroeconomic models usually encompass considerable expert information on the functioning of product and labour markets in individual countries, which is essential for identifying and understanding the factors that determine inflation persistence. Third, by their very nature, large-scale macroeconomic models are especially suited to the investigation of the response of inflation to well articulated macroeconomic shocks, and to assess the importance of various channels of transmission.

The approach taken in the paper involves two stages. In the first phase, modelers from each Central Bank were asked to simulate five shocks using their main structural models: a fiscal shock to government consumption, an oil price shock, a total factor productivity shock, a shock to indirect taxes, and a shock to the social security contribution rate. It was expected that these shocks would be more likely to affect inflation in the short to medium term. These simulations were run by each NCB in isolated mode with neither monetary policy nor area-wide trade-spillovers incorporated. In the second stage, the results of these simulations were collected and a linear procedure was used to approximate results including trade-spillovers and systematic monetary policy in the form of a euro-area-wide standard Taylor rule supplemented by an endogenous exchange rate according to a UIP condition. The derived results were used to measure inflation persistence. Finally, an investigation of the individual factors that determine the inflation persistence was undertaken via a short questionnaire to report the experience of the country experts.

The main finding from this exercise are that only the fiscal shock, and to a lesser extent the TFP shock, generated marked inflation persistence. In contrast, the indirect tax shock and the oil price shock seem to be much less persistent in the five year window considered in this exercise. The social security shock could also be characterised as a less persistent shock for the majority of the countries, however, at the euro area level some weak persistence was observed. These conclusions are robust if we consider either the private consumption or the GDP deflator. Moreover, if trade spillovers are taken

into account, the results remain practically unchanged. If in addition an endogenous monetary policy is implemented, it is generally the case that somewhat lower inflation persistence is observed.

With regard to the sources of persistence, the information contained in the paper indicates that the strength of the propagation mechanism and its capacity to generate inflation persistence is crucially affected by the responsiveness of wages to employment, by the sluggishness in the adjustments of the demand components, and by the speed of adjustment of employment to output and wage changes. These three sources of inflation persistence generally dominate the other sources in the judgmental rankings made in this paper. Moreover, a more quantitative investigation of the sources of inflation persistence based on the elasticity of wages with respect to unemployment and prices in the respective NCB's model equations tends to corroborate these views.

1. INTRODUCTION

This paper analyses the response of inflation in the euro area to various macroeconomic shocks through the use of Eurosystem macroeconomic models. The paper contributes to the Eurosystem's Inflation Persistence Network (IPN), and the results reported in the paper have been produced in collaboration with the Working Group on Econometric Modelling (WGEM). The IPN studies inflation persistence from a variety of angles, such as micro-data, surveys on price-setting behaviour, time series models, and DSGE models. The present paper adds to the existing literature for the following reasons.

First, since the paper utilises information coming from national models maintained by the National Central Banks (NCBs) of the Eurosystem, it makes use of models that are actually used in policy-making. For instance, NCBs use these models in scenario-analyses to gauge the impact of various shocks on – inter alia – inflation. For this reason, this set of models provides a natural laboratory to study inflation persistence. Furthermore, the features and properties of the models are already extensively documented.

Second, NCBs macroeconomic models usually encompass considerable expert information on the functioning of product and labour markets in individual countries, which is essential for identifying and understanding the factors that determine inflation persistence.

Third, by their very nature, large-scale macroeconomic models are especially suited to the investigation of the response of inflation to well articulated macroeconomic shocks, and to assess the importance of various channels of transmission. Although there are a large number of potentially interesting macroeconomic shocks, the focus of this paper is on shocks that are thought likely to affect inflation in the short to medium run. In part for practical reasons, the number of shocks is limited to five: a shock to government consumption, a shock to oil prices, a shock to total factor productivity (TFP), a shock to indirect taxes, and a shock to the social security contribution rate.

This paper is structured as follows. In the next section we provide a description of the models used in this exercise. Following this we discuss the exercises that have been undertaken and how they have been derived from the model results. As the joint use of the models posed a number of challenges, not least of an organisational nature, a great deal of effort was put into the design and implementation of these exercises. In the subsequent section we discuss the results, primarily at the euro area level, although some references are also made to noteworthy country-level outcomes. Following this discussion, we identify the likely main sources of persistence in these model results and then the final section concludes.

The main finding of this paper is that only a fiscal shock, and to a lesser extent a Total Factor Productivity (TFP) shock, can generate marked inflation persistence. For the most part, shocks to indirect taxes, oil prices and social security contributions generate far less persistent inflation responses. When an endogenous monetary policy is implemented, it is generally the case that somewhat lower inflation persistence is observed. As regards the sources of persistence, the strength of the propagation mechanism and its capacity to generate inflation persistence appears to be crucially affected by the responsiveness of wages to employment, the sluggishness in the adjustments of the demand components, and the speed of adjustment of employment to output and wage changes.

2. EURO AREA CENTRAL BANKS' LARGE SCALE STRUCTURAL MODELS

The models used in this exercise are the large-scale structural models of the central banks of the euro area.[1] These models are used extensively within central banks for policy analysis and to assist in the preparation of economic projections. They have been used in a number of published studies, in particular for the analysis of monetary policy transmission (see for instance: BIS, 1995, van Els et al, 2003 and Berben et al, 2004).[2]

These models can be very large with up to 1000 equations, of which up to 100 are estimated behavioural relationships, although the typical size is around 100 equations, of which 25 are estimated.[3] Nearly all of these models are estimated, at least in part, and considerable emphasis is placed on fitting the data of the economy that they seek to represent. The estimation periods for the behavioural relationships in each model can vary significantly in line with the availability of data across countries. The maximum estimation period generally runs from the mid 1960s or early 1970s to the present day. However some models – such as those from the central banks of Austria, Greece, Ireland, Belgium, and Spain – have a shorter estimation period starting in the 1980s.

Despite the emphasis on data fitting, in most cases the modellers have chosen to estimate key behavioural relationships while keeping a close eye on the model properties required by theory (e.g. constraining certain parameter values where necessary or imposing longer-term restrictions: in both cases such restrictions are normally tested). The most widely used approach to estimation is to model

[1] The Portuguese model was not included as its results were only available on an annual basis. This precluded the analysis of inflation persistence at a quarterly frequency. Hence when aggregate results are discussed, these refer to the euro area excluding Portugal.

[2] Although these exercises did not aim to examine persistence, their results can also be examined from this perspective. In Van Els et al (2003), it is noteworthy that inflation persistence following a monetary policy shock was lowest in Finland which is also a general pattern seen in the results reported for various shocks in this paper for reasons that are explored in more detail later.

[3] In the case of multi-country models, the number of estimated equations can be considerably higher. The model of the Finnish economy has no estimated equations as it relies only on calibrated behavioural relationships.

the main behavioural equations in an error-correction format with a process of gradual adjustment towards a long-run level. The speed of adjustment towards the long run is generally determined by the data and this will be an important source of both real and nominal persistence in these models.

There is no single common modelling philosophy and a range of theoretical and empirical approaches have been employed. Nonetheless, the models appear to share some common features. Many have evolved significantly in recent years reflecting theoretical and empirical advances. Although these models tend not to be fully micro-founded, most now embody the "neoclassical synthesis" featuring a long-run vertical supply curve combined with an important role for demand effects in the short run. Whilst the models have this general design feature, there can be important differences in the length of time it takes for short-run demand effects to die out and for the long-run supply-side results to dominate. Intertemporal decision-making and dynamic optimisation play an important role in the specification of some of the models considered. Some of the models also contain complex dynamic adjustment processes, including both forward-looking and backward-looking elements. Another important issue that has also been reflected in the development of many of the models is the use of monetary and fiscal policy rules.

These models can generate persistence in inflation, in response to economic shocks, from a number of sources. The first is persistence in output. Typically output is disaggregated into the standard national accounts expenditure components and each one is determined by a behavioural relationship within the model. Hence real persistence can emerge from, for example, consumption smoothing or adjustment costs in investment.

The next source of persistence is in the labour market. Typically these models include what are labelled as a labour demand/employment and labour supply/wage equations. A common, although by no means universal approach is to adopt a 'right to manage' bargaining framework whereby firms and unions bargain over the real wage and then firms set employment on the basis of the agreed wage. Persistence in employment may emerge due to adjustment costs in employment, both in terms of hiring and firing. Persistence in wages may emerge as unions, or imperfectly competitive firms, seek to resist wage adjustments in response to economic shocks. The extent of this persistence will depend on the estimated coefficients in the employment and wage equations of these models. The role of the labour market in generating persistence – and how this links with the individual model equations – is given special attention later in this paper.

Another factor which may affect overall inflation persistence is the response of the mark-up. Prices in these models are generally set as a mark-up on unit labour costs and import prices. The models allow for sluggish adjustment in the mark-up due, for instance, to the presence of price adjustment costs. The lack of dynamic homogeneity in the main price equations of some models could be an additional factor preventing the return of inflation to its baseline level. Once again, the extent to which such

persistence exists is determined by the data. Finally, the response of import prices themselves can be a source of persistence, particularly for shocks involving foreign or commodity prices and the exchange rate.

Although the large-scale structural models of the central banks of the euro area share some common features, as was indicated above, substantial differences remain. The volume by Fagan & Morgan (2005) documents these differences (and the similarities) in some detail, discussing both the various modelling approaches that have been adopted as well as the transmission of various shocks in the models. This raises the question of to what extent observed cross-country differences in the responses to shocks that the models generate are due to differences in modelling strategies or reflect differences in the underlying economies. Berben et al (2004) examine the observed differences in the transmission of a particular shock, a euro area monetary policy shock, in the central banks' models. They argue that these differences match - to a certain degree - observed characteristics of the euro area countries. However, they also show that particular features of the models that are not related to the underlying economies can have an important bearing on the observed differences in the transmission of monetary policy. Inevitably similar considerations apply to the macroeconomic shocks that we study in this paper and, to the extent possible, we also take into account some of these when discussing our results.

3. DESCRIPTION OF THE EXERCISES UNDERTAKEN

Since the exercises aim to analyse sources of inflation persistence, the simulations were chosen to have the largest potential effect on inflation at business cycle frequencies[4]. Against this background, the following *core* simulations were undertaken:

- A permanent increase in real Government consumption by 1 per cent of baseline real GDP.
- A permanent increase of oil prices (in euro) by 10 per cent.
- A temporary increase in TFP leading to a 1 per cent increase from baseline real GDP on impact, with a return to base according to a decay rate of the shock of 0.9, i.e. $shock_t = 0.9\ shock_{t-1}$.
- A permanent increase of the implicit indirect tax rate by one percentage point.
- A permanent increase of the implicit Social Security contribution rate by one percentage point.

[4] The monetary policy experiment run for the Eurosystem's Monetary Transmission Network provides empirical evidence concerning the impact of monetary policy shocks on inflation from the point of view of large macro-models (see Van Els et al. 2003). Although we do not consider monetary policy as a separate source of (dis-)inflation in this paper, the simulations that we use have been subjected to systematic monetary policy, in the form of a Taylor rule. This allowed us to gauge the impact of monetary policy on the persistence of the response of inflation to other shocks.

Results were reported for a total of 20 periods at the quarterly frequency (5 years).

These shocks were chosen as, for the most part, they relate to interesting sources of costs that could affect inflation in the short to medium term. The exception is the government consumption shock, which was taken as a typical real demand shock. The TFP shock was included as a typical productivity shock. The oil price shock was chosen as a supply-side shock often affecting open economies: although most models include a sizeable demand effect from this shock, most also include oil as a component of production costs. The indirect tax shock and the social security contribution shock were included as they potentially affect the price and wage mark-ups, respectively. With regard to the indirect tax shock, it is worth noting that this has an affect on the marginal cost that takes some time to build up.

The core simulations were run with neither monetary policy nor area-wide trade-spillover calculations, since both are area-wide phenomena and the models were run by each NCB in isolated mode. Instead, a set of linear procedures were used to approximate results including trade-spillovers and systematic monetary policy. These approximate results should be seen as giving an indication of how inflation persistence is affected in a policy environment and not as a fully-fledged analysis of rule-based policies. On the other hand, the presence of a policy rule, however simple, allows a comparison to be made between the two environments and eases possible concerns on the long-run effects of the no-policy exercise. [5]

Monetary policy was run in the form of a euro-area wide standard Taylor rule both with and without an endogenous exchange rate according to a UIP condition. The chosen Taylor rule was a standard static, contemporaneous one based on the output gap (parameter 1.5) and the consumer deflator inflation gap (parameter 0.5), with no feedback from past interest rates. Although more complex rules were technically possible, their use was deemed both inappropriate given the scope of the paper and impractical due to the sheer number of possible alternative exercises.[6] Trade-spillover effects were approximated taking into account intra-area trade weights and the impact of foreign demand and foreign prices on the countries. In order to allow for the calculation of these effects, a total of four additional simulations – which were labelled the *canonical* simulations – were requested from each NCB:

[5] A full technical description of the linear procedures is available on request from the authors.

[6] Although a range of specifications for the Taylor rule were considered, further alternatives could have been considered. For instance, specifications of the Taylor rule sometimes use the lagged output gap to reflect real-time data constraints or inflation forecasts to reflect the forward-looking nature of monetary policy subject to long and variable lags. Such alternatives could potentially have an impact on the inflation persistence results. Ignoring uncertainty may increase monetary policy effectiveness in simulations, lowering inflation persistence, while adopting a myopic perspective may reduce monetary policy effectiveness, increasing inflation persistence. However, as it was felt that the extensive modelling of large numbers of alternative Taylor rules was beyond the scope of this paper. The selected Taylor rule was chosen simply because it is widely used in the literature.

- A shock to the interest rate.
- A shock to the exchange rate.
- A shock to foreign demand.
- A shock to foreign prices other than oil and commodity prices.

The specific path of the shocks in the canonical simulations is not of great importance as they can be reshaped. The shock to the exchange rate was assumed to affect the effective exchange rate vis-à-vis the rest of the world, including other euro area countries. The same applies to the two foreign shocks, i.e. the foreign demand and foreign price shocks. This approach was taken to ensure a consistent set of intra-area weights in the calculations: intra-area trade weights are actually calculated by the linear procedures based on the set of trade weights used for trade-spillover calculations.

The five core simulations were reshaped using the results from the canonical simulations according to the following conventions:

- An active monetary policy was introduced via a euro area-wide Taylor rule in which the output and inflation gaps are measured by the respective deviations of GDP and the consumption deflator from their baseline values.[7] [8]
- The euro exchange rate follows a forward-looking UIP condition based on the resulting interest rate, with the caveat that the terminal condition must necessarily be a return to the baseline exchange rate after the 20 quarters. It should be acknowledged that the choice of this five-year horizon for the UIP condition – which was dictated by the fact that results from NCBs' models were only available for this period - potentially has an impact on the size of the initial exchange rate jump.[9]
- Intra-area trade spillover effects were calculated by changing foreign demand directed to each country according to imports in the other member countries, and changing foreign prices

[7] This procedure assumes that no core simulation permanently shifts potential output or target inflation. Hence, any shift to GDP also shifts the output gap. This may not be strictly true for all models for all simulations (e.g. changes in indirect taxes will have some impact on potential output in some models). No attempt was made at a flexible-price definition of the output gap.

[8] Alternative Taylor rules were used to run further exercises: using unemployment instead of GDP as the activity gap measure, and using the GDP deflator for inflation instead of the consumption deflator. These alternative Taylor rules were used in an exercise run with the AWM, in order to check the linear procedures (information available on request from the authors). They led to significant differences compared to results using the default Taylor rule, but not of a nature to warrant their repetition with country results.

according to the export deflator of other member countries, all re-scaled using country trade weights.

Finally, the linear procedures were also used to aggregate the country results according to fixed country weights in the euro area. In the analysis reported below, both the raw results provided by NCBs and the reshaped results are presented and commented upon. For comparative purposes, the shocks with an active policy and an endogenous exchange rate were also undertaken on the Area Wide Model (AWM) which is a model of the aggregate euro area economy estimated on aggregate data (see, Fagan et al, 2001).

Last but not least, it may be worth noticing that a lot of stress was put on harmonizing all shocks across models, in terms both of the definition of the shocks and their sizes, but that the practical implementation of the exercise varied according to the specific structure of each model. It was thus impossible to collect harmonised views on the relative contribution of the shocks to final inflation variability for each model, which precluded undertaking a standard variance decomposition analysis. Accordingly, all the analysis in the text is made conditional on the specific shock analysed.

4. AN ANALYSIS OF INFLATION PERSISTENCE AT THE AGGREGATE AND COUNTRY LEVEL

We now turn to results of the simulation exercises and the measurement of inflation persistence. To a large extent, the nature of inflation persistence can readily be understood from a simple plot of the path of inflation. This is the approach followed for the aggregated country results (as reported in Figures 1-5) for both the private consumption deflator and the GDP deflator. Each chart reports four lines: the first is the raw input supplied for the linear procedures (i.e. with no trade spillover or active monetary policy); the second set is obtained from the linear procedures once trade spillover effects have been incorporated; the third includes both trade spillovers and a Taylor rule; and the fourth set is obtained when both trade spillovers and a fully endogenous euro area monetary policy (Taylor rule plus a UIP condition for the exchange rate) are taken into account.

Clearly it is not feasible to repeat this for all the (11) individual country results and the AWM, so for the illustrating the cross-country pattern of persistence we rely on a number of summary statistics. In this regard, a number of different measures of inflation persistence are given in Tables 1-3. The first two tables give persistence measures for two different implementations of each of the five core simulations supplied by the NCBs for the consumption deflator (PCD) and the GDP Deflator (YED) respectively. The first set is the raw input supplied for the linear procedures (i.e. with no trade

[9] Alternative initial jumps of the exchange rate were also tested using the AWM (results are available on request from the authors).

spillover or active monetary policy). The second set is obtained when trade spillovers and a fully endogenous euro area monetary policy (Taylor rule plus a UIP condition for the exchange rate) are taken into account.[10] In each case twoe different persistence measures are given:

(1) The half-life of the shock measured in absolute terms. That is the number of periods it takes for the response of inflation to permanently (within our 20 period window) subside below half its initial response. This definition takes into account oscillating behaviour of the response function.[11]

(2) The length of time (in quarters) before the response of inflation reaches its maximum within our 20 period window.

As Tables 1 and 2 contain a large volume of information, Table 3 seeks to present this information in a more condensed form. Table 3 outlines a cross-country and cross-shock classification of the responses in terms of their degree of persistence ("P" Persistent response, "NP" non persistent response and "WP" weakly persistent response). This classification of the results is based on the calculated diagnostics reported in Tables 1 and 2. However in some cases when the statistics gave mixed or inconclusive signals about the shape of the responses the classification is more judgmental, based on visual examination of the inflation responses.

Inevitably such statistics can only tell part of the story and can present misleading results in certain circumstances. For instance, the recorded inflation persistence from the half-life measure will often be strongly influenced by the impact effect of the shock. Hence such statistics should be seen as indicative classifications of the degree of persistence in each of the simulations.

Discussion of the Results

We now use the results and the measures of inflation persistence introduced above to assess differences in the responses of inflation across the five core simulations. Our main focus is on the results for the euro area, but major cross-country differences are also discussed.[12]

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[10] Comparable results for each of the intermediate steps (i.e. first including trade spillovers and then including an active monetary policy with no UIP condition) are also available on request from the authors.

[11] To illustrate this point, consider the example of an impulse response function which oscillates, but decays exponentially towards zero on average.

[12] Two small comments can be made about 'outliers' in the data. In particular, in France the response of PCD to the TFP shock in Q3 of the first year is unexpectedly large and positive for all four scenarios. As a result, the response of PCD for the euro area jumps up as well. When this outlier is removed in calculating the half-lives of the response of PCD, more plausible (higher) estimates of the half-lives are obtained. In Belgium, a large positive response of the import deflator to the indirect tax shock has been recorded in the case when the monetary policy rule has been activated. As a result, one may have the impression that switching on the policy rule in this particular case produces a significant reduction in YED-inflation persistence. But, if we neglect this observation, the half-life of the indirect tax shock equals 4 across the three scenarios and there is no noticeable downward impact of the policy rule on inflation persistence.

The fiscal policy experiment involved a permanent 1 per cent of GDP increase in real government consumption. At the euro area level, the response of inflation is hump-shaped as shown in Figure 1. The first quarter effect of the fiscal shock is to raise PCD-inflation by 0.02 per cent. Then the response of inflation gradually builds up, attaining its maximum after 15 quarters at 0.13 per cent. Compared to the response of PCD-inflation, the response of YED-inflation is somewhat larger. In addition, the response of YED-inflation attains its maximum one quarter earlier. In view of the hump-shaped response of inflation to the fiscal shock, it is not particularly meaningful to calculate the half-life of the initial response. However, since the maximum responses in both cases are attained near the end of the simulation horizon, it is also not possible to assess the half-life of the maximum responses. This implies that we are not able to calculate the degree of persistence in the response of inflation to the fiscal shock in a single statistic. Nevertheless, it is abundantly clear that the degree of persistence is 'high'.

When we allow for trade spillovers, the foreign demand of the individual euro area countries increases as compared to the baseline experiment. As a result, the response of GDP growth to the fiscal shock – and hence of inflation – is somewhat magnified. Yet the hump-shaped pattern of the response of both PCD-inflation and YED-inflation remains largely unchanged. Hence, we conclude that allowing for trade spillovers does not materially change the degree of the persistence in the response of inflation to the fiscal shock.

When we allow for trade spillovers and impose a euro area monetary policy rule, the response of inflation is noticeably dampened. Again, the response builds up gradually, attaining its maximum after 9 quarters at 0.09. The response of the YED-inflation is also more muted when the monetary policy rule is switched on. Finally, we also run an experiment in which we impose a UIP condition on the euro exchange rate. This implies that following the monetary tightening, the euro appreciates, and hence the trade deflators decrease. This triggers a short-lived discrepancy between the response of PCD-inflation and YED-inflation in the first quarter. It reflects the fact that the import deflator falls by more than the export deflator in the first quarter as well as that the real exchange rate has a direct impact on the mark-up in the GDP deflator equation. Overall, imposing a UIP condition has only a limited impact on the observed degree of inflation persistence.

As discussed in the previous section, results for the AWM are also reported in the last line in the table. These show that persistence tends to be higher in response to the fiscal shock in the AWM than is the case for the aggregated country results. This view is supported by the response of both YED and PCD deflators.

The response of the euro area average masks some notable cross-country differences. Inflation is less persistent in Belgium, Finland, the Netherlands and Spain. This seems – in part - to be due to the functioning of the labour market, an issue which we take up in more detail later in the paper. In

Belgium, wages hardly react to the fiscal impulse, which also explains why inflation does not change. In contrast, in Finland and the Netherlands unit labour costs rise quickly (after an initial drop). The fiscal shock leads to a marked decrease in the unemployment rate, pushing up wage demands. Also in Spain, the labour market reacts comparatively quickly. Finally, in Finland there is a comparatively quick crowding-out of the fiscal shock, especially in investment and exports.

The effects of an oil price shock, in which oil prices (in euro) permanently increase by 10 per cent, are fairly modest as shown in Figure 2. The response of PCD-inflation peaks (0.06 per cent) in the first quarter, and then gradually tapers off. In this case, the half-life of the oil price shock is two quarters. The response of YED-inflation, which initially falls as the rise in oil prices raises the import deflator, reaches its maximum after three quarters. It then takes six quarters for the response of YED-inflation to subside below 50 percent of its maximum response. Hence, neither the response of PCD-inflation, nor that of YED-inflation, appears very persistent.

When we allow for trade spillovers, foreign demand for individual euro area countries decreases slightly as compared to the baseline experiment, exerting a downward influence on the response of inflation in the second half of the simulation horizon. However, the degree of persistence in the responses of both PCD-inflation and YED-inflation remains largely unaffected.

When, in addition, the monetary policy rule is switched on (either with or without UIP), the response of inflation to the oil price shock is marginally dampened. Since inflation (and GDP growth) does not respond strongly to the oil price shock when the monetary policy rule is switched off, there is only a limited response in the short-term (and long-term) interest rate when the policy rule is in operation. In general, the initial response of YED-inflation is smaller than the response of PCD-inflation because the increase in oil prices induces an increase in the import price deflator. The results for the AWM are very similar in the case of the PCD with very little persistence reported. As regards YED inflation, very little impact is reported in the first five years, although the statistics presented in Table 2 calculated literally implies a high degree of persistence

Concerning cross-country differences, the response of inflation to the oil price shock appears to be more persistent in Luxembourg and Greece, attaining its maximum after 5 and 7 quarters, respectively. In the case of Luxembourg, this may be partly linked to the practice of backward-looking wage indexation.[13] Furthermore, in Finland the response of PCD-inflation oscillates, and is positive on average in year 1, 3 and 4, but negative in year 2 and 5.

[13] This result may also partly reflect the fact that Luxembourg's quarterly results were obtained by quadratic interpolation of simulations from an annual model. Hence persistence measures calculated at quarterly frequency are subject to greater uncertainty for Luxembourg, limiting comparability with those of other countries.

The total factor productivity (TFP) shock involves a temporary positive shift in TFP in the first quarter by 1 per cent. This temporary shock is then propagated through an AR(1) process with parameter 0.9. The TFP shock exerts a downward impact on inflation over the entire simulation horizon as shown in Figure 3. The response of both PCD-inflation and YED-inflation to the TFP shock is oscillatory and rather persistent. After an initial drop, both PCD and YED inflation return slightly above their baseline levels in second quarter, before falling below baseline in the third quarter. Subsequently both indicators return sluggishly to their baseline levels by the end of the simulation horizon.

When we allow for trade spillovers, the foreign demand of individual euro area countries hardly changes. As a result, the degree of persistence in the response of inflation remains unchanged. When we switch on the policy rule, the response of both PCD- and YED-inflation become less persistent and statistics measuring persistence decline. When in addition we impose the UIP condition, the initial response of PCD-inflation becomes somewhat smaller, while the initial response of YED-inflation is unaffected. The AWM results generally indicate somewhat less persistence, both for YED and PCD inflation, than is the case for the aggregated results.

The cross-country differences in inflation-responses to the TFP shock are rather large. On the one hand, the responses in countries like Germany, Spain, Greece, Ireland and Italy are hump-shaped, in contrast to the exponential decay pattern found at the euro area aggregate level. Nevertheless, the responses of inflation to the TFP shock in these countries remain fairly persistent. On the other hand, in Finland and France the response of inflation is relatively rapid, while in the Netherlands the initial response is quite strong but then the responses sluggishly deviate from base before edging down by the end of the simulation period. As in the case of the fiscal shock, the difference in responses between the two groups of countries may be linked to the functioning of the labour market as, in the latter group, unit labour costs react strongly and return to baseline swiftly. Finally, inflation in Luxembourg appears to be unresponsive to the TFP shock, which may reflect its high degree of openness.

The indirect tax shock, implemented as a permanent 1 per cent shock to the average VAT rate, has a temporary impact on inflation as shown in Figure 4. The initial impact on both PCD-inflation and YED-inflation is approximately 0.5 per cent. In the second quarter, both inflation measures have broadly returned to their baseline levels and hence the half-life of the initial shock is only one quarter. Neither allowing for trade spillovers, nor including the monetary policy rule and UIP, has a material impact on the response of inflation to the indirect tax shock. A similar pattern, of virtually no inflation persistence, is also found when using the AWM.

There are a number of countries for which the response of inflation differs from that for the euro area aggregate. In Austria, the response of PCD-inflation is hump-shaped, attaining its maximum after three quarters and slowly declining afterwards. However, the response of YED-inflation, on the other hand, is similar to that of the euro area aggregate. In Belgium, the response of YED-inflation is also

more persistent than the euro area aggregate. Finally, in Ireland, there is a marked difference between the response of YED-inflation and PCD-inflation: while PCD-inflation returns to base quickly, YED-inflation does not decrease at all.

The social security shock is defined as a 1 percent point permanent increase in the employer's social security contributions. At the euro area level the response of both PCD and YED inflation is fairly persistent (half-life equal to 10 and 7 respectively) as shown in Figure 5. The social security shock pushes up the export deflator as well. This explains why the response of YED-inflation initially exceeds the response of PCD-inflation. As a result of the increase in the export deflator, exports fall below their baseline level. After two quarters, substantial differences between the responses of YED-inflation and PCD-inflation have disappeared. Allowing for trade spillovers and including the monetary policy rule and UIP reduces the degree of persistence of the response of inflation to a limited extent. The AWM also reports a similar pattern of inflation persistence.

Concerning cross-country differences, in contrast to the euro area aggregate, inflation in Germany and Greece hardly shows any response to the social security shock. On the other hand, in Belgium, France and Spain the response of inflation exhibits little tendency to return to baseline within the simulation horizon. In the latter two countries, the limited response of inflation is in line with the small impact of the social security shock on unit labour costs.

5. SOURCES OF PERSISTENCE

In order to improve our understanding of what underlies the results discussed in the preceding section, we have also examined the sources of persistence in the model results.[14] It was not feasible to undertake this analysis in a completely definitive way, for example as was undertaken by Van Els et al (2003) for the identification of channels of monetary policy transmission.[15] Instead, we looked at the issue from two angles. The first involved seeking model proprietors' assessments on the sources of inflation persistence in their models. The second involved looking at certain features of the models, in particular the wage and price equations and the treatment of expectations to consider how these may affect the results reported.

Input from Model Proprietors

We approached each of the model proprietors and asked them for their assessment on the sources of persistence in their models for each of the five simulations. In each case we asked them for their

[14] For some recent literature on sources of inflation persistence in micro-founded general equilibrium models see papers by Altig et al (2005), Christiano et al. (2001) and IMF (2004).

assessment on the role of persistence in output, employment, wages, the mark-up and import prices in explaining the overall persistence observed in the simulation. The assessment for each source of persistence could be either 'very important', 'important' or 'not so important'. Once we collected these responses we created an index where the responses were given scores of three, two and one respectively. We then calculated the simple average across countries and the weighted aggregate.[16]

The assessments on the sources of persistence are reported in Tables 4-8. When assessing these responses it is important to bear in mind that these measures are merely indicative and the values reported are based mainly on subjective assessment and not on simulation analysis using the individual models. In particularly there was no precise metric for scaling the responses and hence there may be considerable variation in respondents' judgements on what constitutes a "very important" factor affecting persistence.

For the fiscal shock, it appears that the modellers judged the role of output, employment and wages to be of roughly equal importance. However, there was a tendency for the larger countries to report output persistence to be the most important, as can be observed from the difference between the simple average and the weighted aggregate. Neither the mark-up nor import prices were thought to play much of a role in inflation persistence in this shock. However, this is not the case for the oil price shock, where import prices are generally agreed to be the most important source of persistence. Wage formation provides the next most important source, presumably linked to the possibility of second round effects following an oil price shock.

As regards the TFP shock, the labour market – either employment or wages – was rated the most important source of persistence in nearly all cases (except Ireland and France). Output persistence was also judged to matter, although its role was typically thought to be not quite so large. The mark-up was expected to play a more minor role – except in Spain – and in no case were import prices thought to be an important factor. As regards the indirect tax shock, overall it was felt that there was a roughly equal role for persistence in output, employment and wages. A few countries also considered that the mark-up had an important role (Greece, France and Finland). However, only in the case of Belgium was there thought to be an important role for persistence in import prices. A similar pattern emerges for the social security shock. However, the role of the labour market variables - employment and wages - is thought to be more important, whilst that of output is judged to be somewhat diminished in this shock.

Role of wage and price equations

The discussion of the cross-country differences in the inflation-response to various shocks indicated that the observed differences in inflation persistence may be related to the functioning of the labour

[15] It is not straightforward to isolate the sources of inflation persistence in the way in which interest rate effects could be isolated in the van Els et al. (2003) study.
[16] Using GDP weights at PPP constructed for the year 2000.

market, particularly in the case of the shocks to fiscal policy and TFP. Also the qualitative assessment on the sources of inflation-persistence points towards an important role for the wage and price equations. Therefore, we asked model proprietors to provide details on the specification of the wage and price equations in their models. On the basis of this information, we calculated a number of single equation elasticities, as shown in Tables 9-10. These elasticities provide for a highly stylised representation of the dynamics in the wage-price blocks of the models.[17] Some of the elasticities are missing, since not all variables feature in the wage and price equation of each model.[18]

As mentioned earlier, the response of inflation to a fiscal policy shock is less persistent in Belgium, Finland, the Netherlands and Spain. We thought that this was in part likely to be due to the functioning of the labour market and the single equation elasticities tend to support this notion. Indeed, in Finland, Spain and the Netherlands, wage inflation reacts comparatively strongly to changes in the unemployment rate, see Table 10. In Ireland and France, the response of wage inflation to changes in the unemployment rate is also rather strong. However, inflation is more persistent in these countries, although for different reasons. In Ireland, the reaction of inflation to wages is more delayed when compared with Finland, Spain and the Netherlands (see Table 10), while in France the response of wage inflation to unemployment is more protracted. Finally, in Belgium wages are indexed to a consumption price index, ruling out direct feedback from (un)employment to wages. This partly explains the limited response of wages – and hence of inflation - to the fiscal impulse.

The cross-country differences in the reaction of wage inflation to unemployment we observe are likely to reflect to some extent differences in labour market institutions as well as the effectiveness of the implemented active labour market policies. Indeed, Layard et al. (1991, chapter 9) show that an increase in the benefit duration tends to reduce the impact of unemployment on wages. Nickell et al. (2003) find that a reduction in the benefit replacement ratio, a decrease in the union density, and an increase in the level of coordination of wage bargaining all reinforce the response of wages to unemployment.[19]

Cross-country differences in inflation-responses to the TFP shock were found to be rather substantial. In Germany, Spain, Greece, Ireland and Italy, the responses of inflation are hump-shaped, while at the euro aggregate level we found an exponential decay pattern. In the latter three countries, this reflects the delayed response of unit labour costs to the increase in TFP. In Spain and Greece, the initial increase in productivity is quickly offset by an increase in wages, while in the Irish model the increase

[17] One should bear in mind that the wage and price equations are part of a larger structural model of the economy. The single-equation elasticities should be interpreted accordingly and are not to be compared to elasticities derived from reduced-form wage and price equations.
[18] The table refers to the main driving price variable, which varies across countries.
[19] An in-depth analysis of the wage equation elasticities in Table 10 in terms of cross-country differences in labour market institutions would be interesting but is clearly beyond the scope of the present paper.

in TFP only gradually translates into a reduction in labour costs. In the German model, however, unit labour costs do not enter the price equation directly which means that the deflationary response builds up only gradually. A similar reasoning applies to the Italian model. On the other hand, in Finland, France and the Netherlands, the response of inflation is relatively rapid. Generally speaking, in these countries the increase in productivity initially translates into a decrease in unit labour costs since wages react with a lag to changes in productivity. Furthermore, unit labour costs have a direct downward effect on prices.

Treatment of expectations

Another potential factor which may affect persistence in these models is the treatment of expectations. For the most part, the models used in this exercise do not allow for forward-looking expectations outside of the determination of the exchange rate and long-term interest rates. The two main exceptions to this are the models of Belgium and Finland which incorporate a wide range of forward-looking behaviour in the goods, labour and financial markets (see Table 11). However, normally the inclusion of forward-looking terms in macroeconomic models would be expected to speed the adjustment in response to macroeconomic shocks.[20] Therefore, it seems likely that the treatment of expectations may have an influence on the persistence reported by these models, which could be an important factor to take into account when making cross-country comparisons – particularly in the case of Belgium and Finland.[21]

Against this background, it is noteworthy that reported inflation persistence is relatively low in Finland compared with the other countries. The average half-life from the raw results supplied by the NCBs was 6 quarters compared with 11 quarters at the euro area level. In contrast, persistence in Belgium was, on average, broadly similar to the euro area aggregate. In order to check the importance of this factor, the Belgian and Finnish central banks ran an additional set of simulations with backward- rather than forward-looking expectations to investigate the importance of this factor. They found little role for forward-looking expectations in reducing recorded inflation persistence. Hence, the cross-country comparability of the results is unlikely to be significantly affected by the treatment of expectations in these countries.

[20] See, for instance, McAdam & Morgan (2003).

[21] An experiment using the NiGEM model – which includes a wide range of forward-looking elements - found that including these could lead to a modest reduction in recorded persistence. For example, for an oil price shock the half-life in terms of inflation persistence was 7 quarters with only backward-looking expectation formation and 5 quarters when expectations were forward-looking. Results available on request from the authors.

6. CONCLUSIONS

This paper has aimed to develop our understanding of inflation persistence following various macroeconomic shocks. It combines diverse information from twelve different models (built on different philosophies), judgmental elements and experts' views. In this framework the paper sheds light on the responses of prices to specific shocks, (policy interventions) or regime changes (oil shock) with standard rule-based monetary policy responses and country interdependencies. It is important to note that the contribution of the WGEM members was invaluable, not only in the implementation of the different shocks in their national models but also in the investigation of individual factors that determine inflation persistence and the assessment of the importance of various transmission channels.

The approach taken involved two stages. In the first phase, modelers from each Central Bank were asked to simulate five shocks using their main structural models: a fiscal shock to government consumption, an oil price shock, a total factor productivity shock, a shock to indirect taxes, and a shock to the social security contribution rate. It was expected that these shocks would be more likely to affect inflation in the short to medium term. These simulations were run by each NCB in isolated mode with neither monetary policy nor area-wide trade-spillovers. In the second stage, the results of these simulations were collected and a linear procedure was used to approximate results including trade-spillovers and systematic monetary policy in the form of a euro-area-wide standard Taylor rule supplemented by an endogenous exchange rate according to a UIP condition. The derived results were used to measure inflation persistence. Finally, an investigation of the individual factors that determine the inflation persistence was undertaken via a short questionnaire to report the experience of the country experts.

The main finding from this exercise is that only the fiscal shock, and to a lesser extent the TFP shock, generated marked inflation persistence. On the other hand the indirect tax shock and the oil price shock seem to be much less persistent in the twenty-period window considered in this exercise. The social security shock could also be characterised as a less persistent shock for the majority of the countries, however, at the euro area level some weak persistence was observed. These conclusions are robust if we consider either the private consumption or the GDP deflator. Moreover, if trade spillovers are taken into account, the results remain practically unchanged. If in addition an endogenous monetary policy is implemented, it is generally the case that somewhat lower inflation persistence is observed.

Turning finally to the sources of persistence, the information gathered from the model proprietors indicates that the strength of the propagation mechanism and its capacity to generate inflation persistence is crucially affected by the responsiveness of wages to employment, by the sluggishness in the adjustments of the demand components, and by the speed of adjustment of employment to output

and wage changes. These three sources of inflation persistence generally dominate the other sources in the judgmental rankings made in this paper. Moreover, a more quantitative investigation of the sources of inflation persistence based on the elasticity of wages with respect to unemployment and prices in the respective NCB's model equations also tends to corroborate these views.

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TABLE 1: MEASURES OF INFLATION PERSISTENCE (Private Consumption Deflator, PCD)

	Input for Linear Procedures		Trade Spillover and All Rules	
Country	Half-life	Time to reach maximum	Half-life	Time to reach maximum
1. Fiscal Shock				
Austria	20	12	20	6
Begium	18	5	7	2
Finland	11	2	20	1
France	20	16	20	14
Germany	20	14	20	20
Greece	20	17	20	20
Ireland	20	19	2	2
Italy	20	20	20	1
Luxembourg	20	5	19	1
Netherlands	20	7	20	7
Spain	16	4	18	4
Euro Area	20	15	20	11
AWM			20	20
2. Oil Price Shock				
Austria	2	2	20	2
Begium	7	2	8	2
Finland	1	1	1	1
France	2	1	2	1
Germany	20	5	20	5
Greece	14	7	14	7
Ireland	20	3	20	3
Italy	2	1	2	1
Luxembourg	20	5	20	5
Netherlands	7	3	7	3
Spain	1	1	1	1
Euro Area	2	1	2	1
AWM			1	1
3. Total Factor Productivity Shock				
Austria	20	2	20	2
Begium	7	2	8	3
Finland	1	1	1	1
France	3	1	3	1
Germany	20	14	20	13
Greece	20	8	20	8
Ireland	20	13	20	11
Italy	20	15	20	15
Luxembourg	16	16	20	5
Netherlands	19	13	19	13
Spain	20	4	20	4
Euro Area	18	1	15	1
AWM			4	1
4. Indirect Tax Shock				
Austria	20	5	20	3
Begium	3	1	3	1
Finland	1	1	1	1
France	1	1	1	1
Germany	1	1	1	1
Greece	1	1	1	1
Ireland	1	1	1	1
Italy	4	1	1	1
Luxembourg	1	1	8	1
Netherlands	1	1	1	1
Spain	3	1	3	1
Euro Area	1	1	1	1
AWM			1	1
5. Social Security Contribution Shock				
Austria	2	2	20	2
Begium	20	7	20	7
Finland	1	1	1	1
France	13	2	12	2
Germany	20	3	20	16
Greece	20	20	20	9
Ireland	5	1	5	1
Italy	3	1	3	1
Luxembourg	1	1	9	1
Netherlands	3	1	3	1
Spain	20	7	20	8
Euro Area	10	2	7	2
AWM			3	3

Additional statistics capturing the effects of trade spillovers separately as well as the effects of trade spollovers and the Taylor rule are not presented in the Tables order to save space. They are available on request fron the authors.

TABLE 2: MEASURES OF INFLATION PERSISTENCE (GDP Deflator, YED)

	Input for Linear Procedures		Trade Spillover and All Rules	
Country	Half-life	Time to reach maximum	Half-life	Time to reach maximum
1. Fiscal Shock				
Austria	20	3	20	3
Begium	15	3	2	1
Finland	5	1	4	1
France	20	14	20	13
Germany	20	14	20	1
Greece	20	17	20	20
Ireland	20	12	19	8
Italy	20	20	1	1
Luxembourg	13	5	5	1
Netherlands	20	2	1	1
Spain	17	4	20	4
Euro Area	20	14	11	1
AWM			20	1
2. Oil Price Shock				
Austria	2	2	20	2
Begium	3	1	3	1
Finland	20	20	20	20
France	8	2	4	2
Germany	6	1	6	1
Greece	14	4	14	4
Ireland	20	16	20	11
Italy	20	5	20	7
Luxembourg	20	5	20	5
Netherlands	20	1	20	1
Spain	14	5	12	5
Euro Area	8	1	3	1
AWM			20	20
3. Total Factor Productivity Shock				
Austria	8	1	7	1
Begium	7	5	6	5
Finland	1	1	1	1
France	3	1	3	1
Germany	20	13	17	13
Greece	20	8	20	8
Ireland	8	2	8	2
Italy	20	17	20	10
Luxembourg	19	5	19	5
Netherlands	20	2	18	2
Spain	9	4	20	4
Euro Area	17	2	10	1
AWM			4	1
4. Indirect Tax Shock				
Austria	1	1	1	1
Begium	4	2	4	3
Finland	1	1	1	1
France	1	1	1	1
Germany	1	1	1	1
Greece	1	1	1	1
Ireland	20	10	15	7
Italy	9	1	14	8
Luxembourg	1	1	1	1
Netherlands	1	1	4	3
Spain	1	1	1	1
Euro Area	1	1	1	1
AWM			1	1
5. Social Security Contribution Shock				
Austria	20	2	20	2
Begium	20	3	20	4
Finland	1	1	1	1
France	7	2	7	2
Germany	20	1	20	1
Greece	20	8	20	8
Ireland	9	5	9	5
Italy	1	1	1	1
Luxembourg	1	1	1	1
Netherlands	1	1	1	1
Spain	20	7	20	20
Euro Area	7	2	2	1
AWM			3	1

Additional statistics capturing the effects of trade spillovers separately as well as the effects of trade spollovers and the Taylor rule are not presented in the Tables order to save space. They are available on request fron the authors.

TABLE 3: TABULAR CLASSIFICATION OF THE CORE SIMULATION RESULTS

Country	Categories	Remarks
1. Fiscal Shock		
Austria	P	
Belgium	NP	
Finland	WP	Rules effective at the beginning of the simulation and destabilising by the end
France	P	
Germany	P	
Greece	P	
Ireland	P	
Italy	P	Rules are effective for YED (NP)
Luxembourg	P	Rules are effective for YED (NP)
Netherlands	P	Rules are effective for YED (NP)
Spain	WP	Slow convergence after Q4
Euro Area	P	
AWM	P	
2. Oil Price Shock		
Austria	NP	
Belgium	NP/WP	NP according to PCD, WP according to YED
Finland	NP/WP	NP according to PCD, WP according to YED
France	NP	
Germany	NP	
Greece	P	Converging steadily after Q7
Ireland	P/WP	P according to YED, WP according to PCD
Italy	NP/WP	NP according to PCD, WP according to YED but converging in the second part
Luxembourg	P	
Netherlands	NP/P	NP according to PCD, Persistent according to YED
Spain	NP/WP	NP according to PCD, WP according to YED
Euro Area	NP	
AWM	NP/P	NP according to PCD, Persistent according to YED, (marked difference in the impact effect)
3. Total Factor Productivity Shock		
Austria	P	Despite the exponentially decay pattern
Belgium	WP/NP	WP according to YED, NP according to PCD
Finland	NP	
France	NP	
Germany	P	
Greece	P	
Ireland	P/WP	P according to PCD, WP (steadily converging after Q2) for YED
Italy	P	
Luxembourg	NP	
Netherlands	P	
Spain	WP	
Euro Area	WP	Slow return to base
AWM	NP	
4. Indirect Tax Shock		
Austria	P/NP	P for PCD, NP for YED
Belgium	NP	
Finland	NP	
France	NP	
Germany	NP	
Greece	NP	
Ireland	P/NP	Market difference between PCD (NP) and YED (P)
Italy	WP	
Luxembourg	NP	
Netherlands	NP	WP for YED in trade spillover and rules simulations
Spain	NP	
Euro Area	NP	
AWM	NP	
5. Social Security Contribution Shock		
Austria	NP	
Belgium	P	
Finland	NP	
France	NP	
Germany	P	
Greece	P	
Ireland	P/NP	P for YED, NP for PCD
Italy	NP	
Luxembourg	NP	
Netherlands	NP	
Spain	P	
Euro Area	NP	
AWM	NP	

TABLE 3: TABULAR CLASSIFICATION OF THE CORE SIMULATION RESULTS

Country	Categories	Remarks
Fiscal Shock		
Austria	P	
Belgium	NP	
Finland	WP	Rules effective at the beginning of the simulation and destabilising by the end
France	P	
Germany	P	
Greece	P	
Ireland	P	
Italy	P	Rules are effective for YED (NP)
Luxembourg	P	Rules are effective for YED (NP)
Netherlands	P	Rules are effective for YED (NP)
Spain	WP	Slow convergence after Q4
Euro Area	P	
AWM	P	
Oil Price Shock		
Austria	NP	
Belgium	NP/WP	NP according to PCD, WP according to YED
Finland	NP/WP	NP according to PCD, WP according to YED
France	NP	
Germany	NP	
Greece	P	Converging steadily after Q7
Ireland	P/WP	P according to YED, WP according to PCD
Italy	NP/WP	NP according to PCD, WP according to YED but converging in the second part
Luxembourg	P	
Netherlands	NP/P	NP according to PCD, Persistent according to YED
Spain	NP/WP	NP according to PCD, WP according to YED
Euro Area	NP	
AWM	NP/P	NP according to PCD, Persistent according to YED, (marked difference in the impact effect)
Total Factor Productivity Shock		
Austria	P	Despite the exponentially decay pattern
Belgium	WP/NP	WP according to YED, NP according to PCD
Finland	NP	
France	NP	
Germany	P	
Greece	P	
Ireland	P/WP	P according to PCD, WP (steadily converging after Q2) for YED
Italy	P	
Luxembourg	NP	
Netherlands	P	
Spain	WP	
Euro Area	WP	Slow return to base
AWM	NP	
Indirect Tax Shock		
Austria	P/NP	P for PCD, NP for YED
Belgium	NP	
Finland	NP	
France	NP	
Germany	NP	
Greece	NP	
Ireland	P/NP	Market difference between PCD (NP) and YED (P)
Italy	WP	
Luxembourg	NP	
Netherlands	NP	WP for YED in trade spillover and rules simulations
Spain	NP	
Euro Area	NP	
AWM	NP	
Social Security Contribution Shock		
Austria	NP	
Belgium	P	
Finland	NP	
France	NP	
Germany	P	
Greece	P	
Ireland	P/NP	P for YED, NP for PCD
Italy	NP	
Luxembourg	NP	
Netherlands	NP	
Spain	P	
Euro Area	NP	
AWM	NP	

TABLE 4: SOURCES OF PERSISTENCE IN THE FISCAL SHOCK

	Sources of Persistence				
	Output	Employment	Wages	Mark-up	Import Prices
Countries					
Germany	3	2	1	1	1
Netherlands	2	3	3	1	1
Greece	2	3	3	1	1
Luxembourg	2	3	1	1	1
Ireland	3	2	3	1	1
France	2	2	2	2	1
Austria	3	2	3	1	1
Spain	3	3	1	1	1
Finland	2	3	3	1	1
Italy	3	2	2	1	1
Belgium	1	1	3	1	1
Average	**2.4**	**2.4**	**2.3**	**1.1**	**1.0**
Aggregate	**2.6**	**2.2**	**1.8**	**1.2**	**1.0**

TABLE 5: SOURCES OF PERSISTENCE IN THE OIL SHOCK

	Sources of Persistence				
	Output	Employment	Wages	Mark-up	Import Prices
Countries					
Germany	2	2	1	1	3
Netherlands	1	2	2	1	2
Greece	1	1	2	2	2
Luxembourg	2	1	1	1	3
Ireland	2	1	1	1	3
France	1	1	2	2	2
Austria	2	1	3	1	1
Spain	2	2	3	1	3
Finland	2	2	2	1	3
Italy	1	1	2	3	3
Belgium	1	1	3	1	3
Average	**1.5**	**1.4**	**2.0**	**1.4**	**2.5**
Aggregate	**1.5**	**1.5**	**1.9**	**1.6**	**2.6**

NOTE: FIGURES IN TABLES 4-8 ARE BASED ON THE FOLLOWING SCORING SYSTEM FOR NCBS' ASSESSMENT ON THE ROLE OF EACH SOURCE OF PERSISTENCE (VERY IMPORTANT=3, IMPORTANT=2, NOT SO IMPORTANT=1).

TABLE 6: SOURCES OF PERSISTENCE IN THE TFP SHOCK

	Sources of Persistence				
	Output	Employment	Wages	Mark-up	Import Prices
Countries					
Germany	3	3	2	1	1
Netherlands	2	3	3	1	1
Greece	1	3	2	1	1
Luxembourg	1	3	1	1	1
Ireland	3	1	3	1	1
France	1	1	2	2	1
Austria	2	3	3	1	1
Spain	3	3	3	3	1
Finland	2	2	3	1	1
Italy	2	3	3	2	1
Belgium	1	2	2	1	1
Average	**1.9**	**2.5**	**2.5**	**1.4**	**1.0**
Aggregate	**2.1**	**2.5**	**2.4**	**1.6**	**1.0**

TABLE 7: SOURCES OF PERSISTENCE IN THE INDIRECT TAX SHOCK

	Sources of Persistence				
	Output	Employment	Wages	Mark-up	Import Prices
Countries					
Germany	2	2	2	1	1
Netherlands	2	2	3	1	1
Greece	2	2	1	2	1
Luxembourg	3	3	1	1	1
Ireland	2	1	3	1	1
France	2	2	2	2	1
Austria	1	1	3	1	1
Spain	3	2	1	1	1
Finland	1	2	2	2	1
Italy	3	2	2	1	1
Belgium	1	1	3	1	2
Average	**2.0**	**1.8**	**2.1**	**1.3**	**1.1**
Aggregate	**2.2**	**1.9**	**2.0**	**1.3**	**1.0**

TABLE 8: SOURCES OF PERSISTENCE IN THE SOCIAL SECURITY SHOCK

	Sources of Persistence				
	Output	**Employment**	**Wages**	**Mark-up**	**Import Prices**
Countries					
Germany	2	2	2	1	1
Netherlands	1	2	3	1	1
Greece	1	1	3	1	1
Luxembourg	3	3	2	1	1
Ireland	2	1	3	1	1
France	2	2	2	2	1
Austria	1	1	3	1	1
Spain	2	3	3	2	1
Finland	2	3	3	2	1
Italy	1	3	2	3	1
Belgium	1	1	3	1	2
Average	**1.6**	**2.0**	**2.6**	**1.5**	**1.1**
Aggregate	**1.7**	**2.2**	**2.3**	**1.7**	**1.0**

TABLE 9

	Elasticity of wage inflation wrt. unemployment				
Countries	1 quarter	1 year	2 years	5 years	10 years
Belgium	na	na	na	na	na
Germany	0.00	0.00	0.00	0.00	0.00
Greece	0.00	0.00	0.00	0.00	0.00
Spain	0.00	-0.22	-0.01	0.00	0.00
France	0.00	-0.18	-0.15	-0.08	-0.03
Ireland	0.00	-0.37	0.01	0.03	0.00
Italy	0.00	0.00	0.00	0.00	0.00
Luxembourg	na	na	na	na	na
Netherlands	0.00	-0.21	-0.08	0.00	0.00
Austria	0.00	0.02	0.01	0.00	0.00
Finland	-0.15	-0.12	-0.02	-0.01	0.00

TABLE 10

	Elasticity of wage inflation wrt. prices				
Countries	1 quarter	1 year	2 years	5 years	10 years
Belgium	0.08	0.00	0.00	0.00	0.00
Germany	0.00	0.00	0.00	0.00	0.00
Greece	0.00	0.27	-0.12	0.00	0.00
Spain	0.47	0.05	0.00	0.00	0.00
France	0.30	0.02	0.02	0.01	0.00
Ireland	0.00	0.07	0.08	0.01	0.00
Italy[a]	1.00	0.00	0.00	0.00	0.00
Luxembourg	na	0.00	0.45	-0.01	-0.01
Netherlands	0.23	0.08	0.03	0.00	0.00
Austria	0.00	0.07	0.04	0.01	0.00
Finland	0.00	0.07	0.05	0.02	0.00

[a] assuming inflation expectations instantaneously adapt to changes in prices

TABLE 11: TREATMENT OF EXPECTATIONS IN NCBS MODELS

Backward-Looking	Forward-looking elements	
	On inflation	**On financial markets and goods markets**
Greece Spain France Ireland Luxembourg Netherlands Austria	Germany Italy	Belgium Finland

Note: Table taken from Berben et al. (2004)

FIGURE 1: RESULTS FOR THE EURO AREA FROM THE FISCAL SHOCK

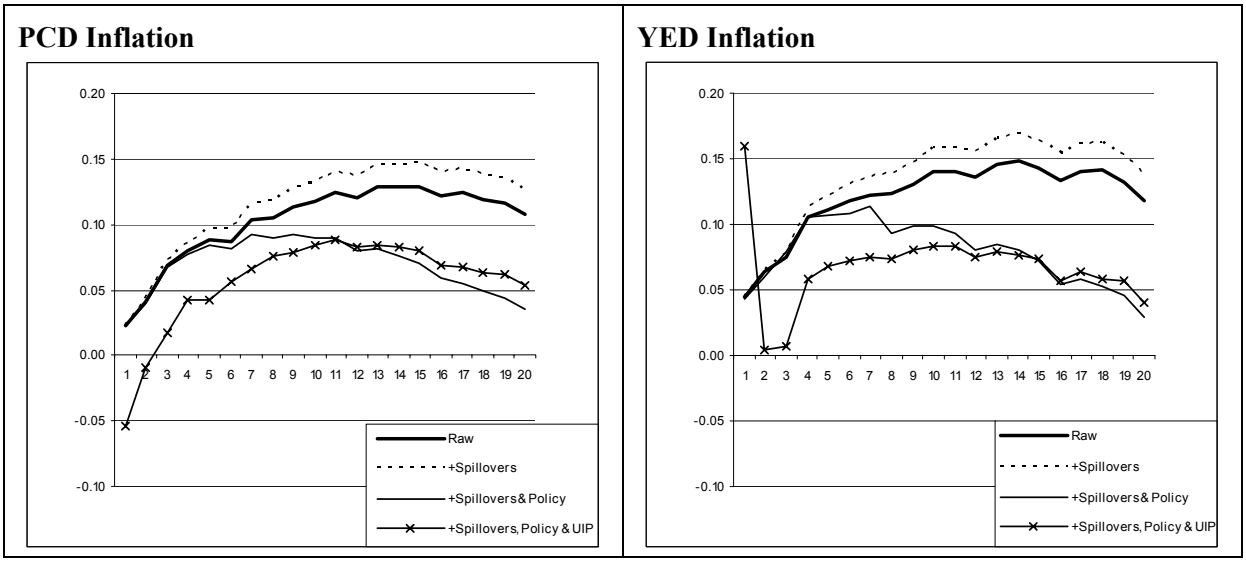


FIGURE 2: RESULTS FOR THE EURO AREA FROM THE OIL PRICE SHOCK

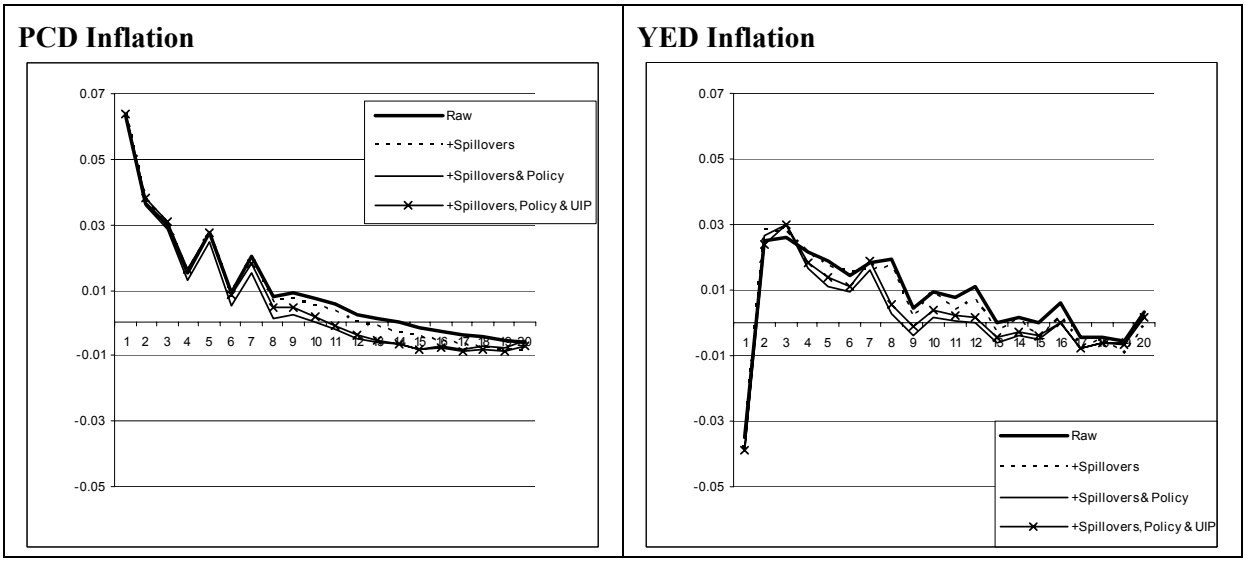


FIGURE 3: RESULTS FOR THE EURO AREA FROM THE TFP SHOCK

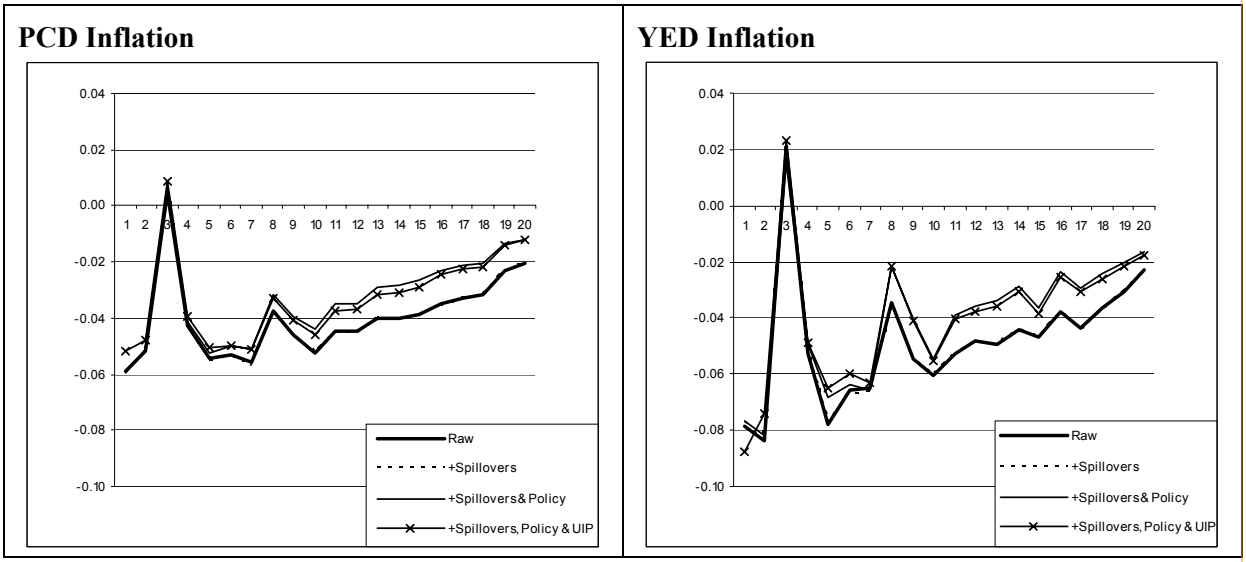


FIGURE 4: RESULTS FOR THE EURO AREA FROM THE INDIRECT TAX SHOCK

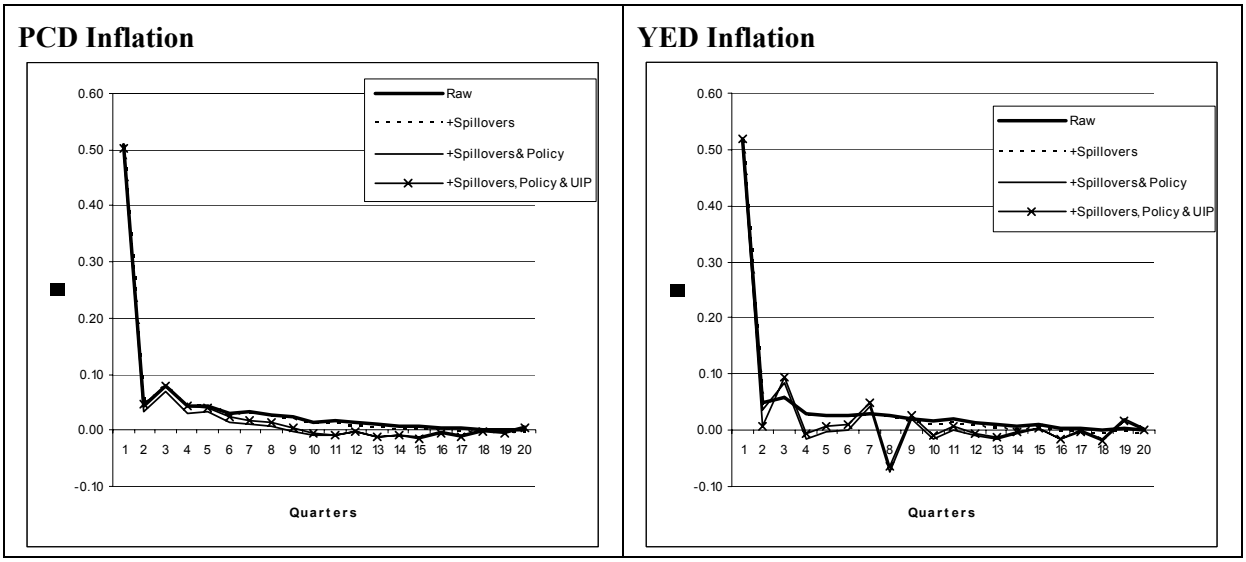
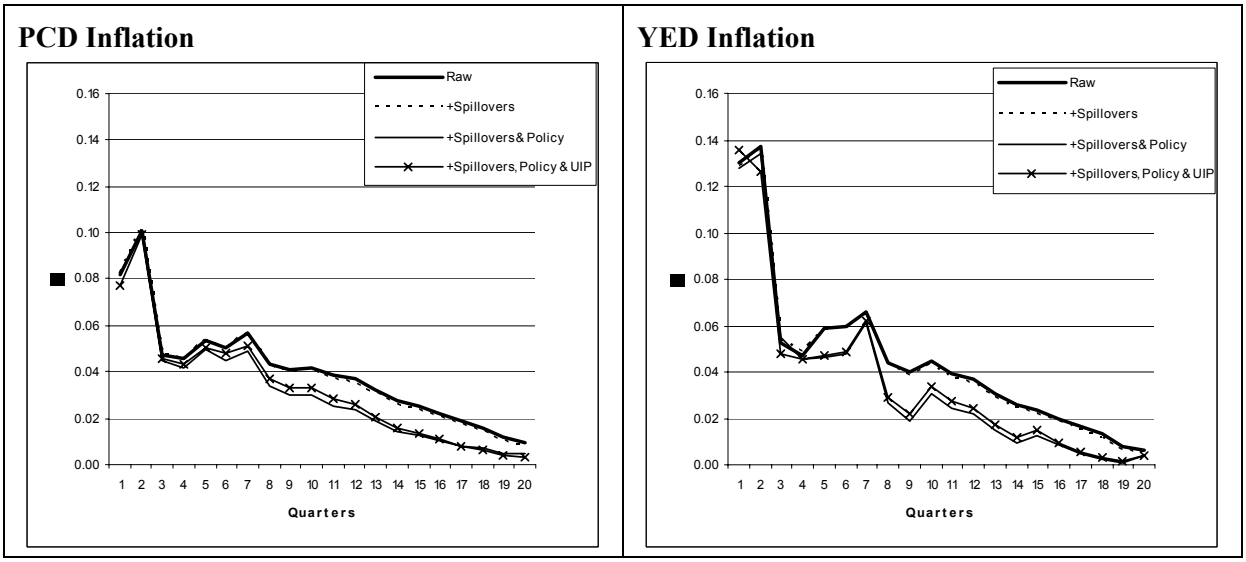


FIGURE 5: RESULTS FOR THE EURO AREA FROM THE SOCIAL SECURITY SHOCK



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