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evidence from macroeconometric models**

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# THE SHORT-TERM IMPACT OF GOVERNMENT BUDGETS ON PRICES: EVIDENCE FROM MACROECONOMETRIC MODELS

by Jérôme Henry[*], Pablo Hernández de Cos[**] and Sandro Momigliano[***]

## Abstract

This paper reviews the existing empirical evidence on the short-term impact on prices of fiscal variables and assesses it against new results from harmonised simulations, conducted with six well-established econometric models used by the ECB and five national central banks (NCBs) of the Eurosystem. The outcome is also compared with results from the European Commission and the OECD models. Overall, a broad consensus appears on the impact on prices of changes in individual government budget items in the euro area. In all cases, changes in government demand and in direct taxes paid by households have a limited impact on prices in the first year while, in contrast, changes in indirect taxes and employers' social security contributions have a relatively large impact. The second year results show that the effects on prices usually take some time to materialise fully; in particular, they often become large for the public consumption shock.

JEL classification: E17, E31, E62.

Keywords: Euro area, model simulations, fiscal policy, prices.

## Contents

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# 1. Introduction[1]

The issue of the impact on prices of fiscal policies is particularly important for governments when taking budgetary decisions, for employers and unions when setting prices and wages, and also for central bankers when selecting the appropriate monetary stance. Focusing on the latter, it is widely recognised that decisions of monetary authorities need to be based on a thorough analysis of determinants of price developments, among which fiscal policies may take a prominent role. As the impact of different budget items on prices and output may vary greatly, it also seems important for central bankers to be in a position to distinguish between the various possible fiscal shocks. In spite of its relevance, it can be argued that this issue has not yet been examined in a fully satisfactory manner, in particular within the euro area.

While the relation between inflation and fiscal balances overall has received some attention, the empirical evidence concerning the impact of specific budget items on prices remains quite limited. In particular, to the best of our knowledge, results for the euro area are sparse. The disaggregated approach needed to analyse separately the impact of various budget items has, moreover, traditionally involved econometric model simulations. One of the drawbacks of this approach is that the results may depend heavily on the modellers' choices. This problem can be lessened by comparing results across different models, but again, such studies are not available for most euro-area countries. An additional source of empirical evidence is the slowly emerging VAR-based literature, which also focuses on some individual budget items. However, data problems limit it to a few countries and ask for caution in interpreting its results.

The limited evidence concerning the impact of fiscal variables on prices also contrasts with the relatively large attention devoted to the analysis of their impact on output. In this area, however, a large uncertainty still exists. For example, Perotti (2001), which reviews the recent theoretical and empirical economic literature on this issue, concludes that "there is clearly no consensus on the basic effects of government spending on output".[2]

In this paper we try to contribute to the literature on the effects of fiscal policy on prices in four respects. First, as we are aware of the potential usefulness of a disaggregated approach, we extend the focus on government expenditure shocks of standard analyses, taking into account four different fiscal shocks. Second, we pay particular attention to the euro area and the countries within it. Third, we focus on results from models of central banks participating in the Eurosystem (*i.e.*, the European Central Bank and the national central banks of the countries which have adopted the euro) and we select a simulation environment commonly used for monetary policy analysis. Fourth, we compare these new results with those obtained from a variety of sources to assess their robustness. To this end, we report results from models of the euro area employed by institutions outside the Eurosystem (OECD and EU Commission), from previous model comparison exercises for the US and the UK, and from VAR studies.

More specifically, we examine the effects of shocks to the following four budget items: 1) government purchases of goods and services, 2) personal income tax, 3) indirect taxes, and 4) social security contributions. As it is to be expected that the short-term effects on prices of changes in personal income taxation are not significantly different from those relating to monetary transfers to households (pensions, wages, etc.), the categories we singled out for our experiment can be viewed as representative of most budget items. In the first exercise, the main issue addressed is the evidence, embodied in these econometric models, concerning the impact on prices through the aggregate demand channel. In the second, we also examine the aggregate demand channel, triggered by the change in disposable income, discussing the role of alternative specifications of the consumption and

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[2] In the recent model comparison presented in Wallis (2003), the impact on output across models is less dispersed, perhaps reflecting greater convergence among models used by policy institutions.

investment functions.[3] In the third exercise, one of the key issues is whether the econometric models we examine embody an immediate and full adjustment of final prices to the change in indirect taxes or, alternatively, include some partially offsetting temporary reaction of pre-tax prices. Finally, in the last exercise we find out what the models say about firms' reactions to a fiscally-induced increase in labour costs (see Chart 1 for a summary of the main channels through which fiscal policy has an impact on prices).

Our comparison exercise involves harmonised simulations carried out with six large or medium-size econometric models held within the Eurosystem. Five refer to individual countries and belong to the following central banks: National Bank of Belgium (BE model), Deutsche Bundesbank (DE model), Banco de España (ES model), Banca d'Italia (IT model) and Banco de Portugal (PT model).[4] One model refers to the euro area as a whole (Area-Wide Model, AWM) and is used by the ECB.[5] While the models differ considerably in several respects, they share the characteristics common to many other macroeconomic models of combining short-term "Keynesian" features with long-term neo-classical properties.[6]

The simulation environment is consistent with the standard counter-factual set-up used, for instance, in the Eurosystem projection exercises, *i.e.* interest rates, exchange rates and fiscal policy variables are left exogenous. Moreover, the sample examined is mostly limited to a two-year horizon, also consistent with a projection simulation environment.

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[3]   Wage bargaining could have also played a role in this experiment, since, according to standard labour market theory, workers negotiate their compensation taking into account their after-tax wage. However, the models under review do not include direct taxes among the short-run determinants of wages. While this absence does not exclude a potential role for this channel, it indicates that, at least in the short term and for the countries examined, there may not be a strong statistical relation between direct taxes and wages.

[4]   Descriptions of the models and their main properties are available in Jeanfils (2000) for Belgium, Deutsche Bundesbank (2000) for Germany, Estrada *et al.* (2004) for Spain, and Banca d'Italia (1986), Terlizzese (1994), Altissimo and Siviero (2002) for Italy.

[5]   Documented in Fagan *et al.* (2001) and Dieppe and Henry (2003).

[6]   The relative homogeneity of the model specifications may be partly due to the fact that the institutions participating in the exercise have similar needs to be satisfied by an econometric model, with forecasting and policy analysis usually high up on the list. Possibly, previous model comparison exercises have also triggered some convergence process across modeling teams, both in terms of framework employed and results obtained.

However, in some cases, results for longer horizons are reported, but only for illustration, as the simulations should in principle be accompanied by additional assumptions.

While it could have been very interesting to extend our simulation horizon more systematically, we refrained from doing so for three main reasons. First, extending the period would have necessarily entailed specifying appropriate reaction functions for monetary and fiscal policies as well as defining an equation for the exchange rate. While doing so could have increased realism, the results would no longer have shown the pure effects of fiscal shocks, becoming less useful for policy advice, which is very often based on such counter-factual simulation results. Second, allowing policy reactions would have made it extremely complex to relate differences in the results across models to the specific linkages they embody between the fiscal block and the other parts of the models. Third, the specification of the policy reactions, although technically closing "fully" the models involved, may not itself be sufficient to render these models suitable for addressing medium-term fiscal issues. For instance, a large number of *ceteris paribus* assumptions implicitly underlie these models – on demographics, labour supply, pension schemes, interest-rate term premiums, etc. These assumptions reflect the large number of exogenous variables in the models that should preferably, in a long-term perspective, be endogenous. To leave these variables unchanged becomes clearly less and less tenable the longer the period of the simulation.

For robustness purposes we also use additional information from outside the Eurosystem. Two econometric models are used (INTERLINK[7] and QUEST[8]), developed, respectively, within the OECD and the European Commission. They are multi-country models, allowing the users to examine shocks affecting either individual countries or the whole area. We have encountered harmonisation issues, since the fully harmonised exercise was limited to the Eurosystem models (for which special simulations were carried out). To deal with this comparability issue we also present additional results using Eurosystem models to assess, for instance, the impact of

[7] Some standard simulation results are reported in Dalsgaard *et al.* (2001).

[8] The results presented for QUEST are those of simulations reported in Brunila *et al.* (2002).

active monetary policy responses on the reported multipliers. Overall, we provide a range of cross-country/cross-model/cross-assumption results, and thus a quantitative assessment along with a robustness check.

Overall, our findings regarding the effects on prices seem less disappointing than those of Perotti (2001) for output. While the differences are not negligible, the overall pattern of responses to the shocks reviewed is relatively similar across models. This may be due to the relative homogeneity of the models we include in our comparison. In recent years, a number of model comparison exercises, some of them also conducted with models supplemented with fiscal and monetary policy modelling and exchange-rate equations, have presumably contributed to this observed convergence (see Wallis, 2003).

The results, while subject to a number of caveats, point to several useful, and hopefully not trivial, conclusions for understanding the connection between fiscal policy and prices in the short term. In particular, the range spanned by our results for each exercise is often sufficiently contained to allow us to draw conclusions on the relative importance for price developments of changes in the various individual budget items.

The rest of the paper is structured as follows. In Section 2 we provide a brief survey of the relevant theoretical and empirical literature studying the relationship between fiscal policy and inflation. In Section 3 we discuss the design of the simulations, a number of comparability problems and some additional caveats. In Section 4 we analyse each of the individual simulations, comparing the results, when possible, with those of other similar projects and of some VAR studies. Section 5 concludes the paper. In Appendix 1 we provide a brief analysis of the main features of the econometric models included in our comparison.

## 2. An overview of the theoretical and empirical literature

The theoretical literature has identified three main channels through which fiscal policy affects prices: seignorage, aggregate demand and aggregate supply. The first channel comes from the obvious link between fiscal policy and inflation when deficits are financed by printing money. This, however, is not currently a realistic alternative for countries where

there is a fully independent central bank, as in the European Monetary Union, where a legal prohibition to finance government deficits also exists (Article 101, formerly 104, of the Maastricht Treaty).[9] Second, fiscal policy can affect prices through its impact on aggregate demand, with a magnitude depending on a number of key factors.[10] Third, prices can be affected through the impact of fiscal policy on aggregate supply. Although this channel is generally discussed with reference to long-term issues, its short-term impact may also be substantial, for example if changes in indirect taxes are promptly shifted to consumers. Significant supply-side effects may also stem from changes in labour income taxes in the presence of labour market rigidities (Alesina and Perotti, 1997).

In addition to these traditionally mentioned channels, the so-called Fiscal Theory of the Price Level (FTPL) has recently emphasised a direct link between the budget balance and the price level in a setting characterised by full employment of resources (Woodford, 2001; Christiano and Fitzgerald, 2000). According to this theory, which applies to a non-Ricardian policy regime – *i.e.,* with no government commitment to adjusting fiscal policy if debt explodes – an increase in the deficit results in a net increase in the permanent income of the private sector. Given that the total available resources of the economy have not changed, the new equilibrium requires an increase in the price level. The internal consistency of this approach is highly disputed (Buiter, 1999 and Niepelt, 2002). Even some of its proponents point out that, while possibly useful as an explanation of some past inflationary episodes, the FTPL does not seem to be particularly relevant for current policy analysis either in Europe, because of institutional constraints, or in the US, where the evidence of the last two decades suggests that governments were ready to adjust fiscal policy when government debt reached high levels (Christiano and Fitzgerald, 2000).

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[9] Moreover, this channel does not seem particularly relevant for economies with sophisticated financial markets, in "which it is difficult for the government to raise large seignorage revenue because of people's ability to substitute away from non-interest-earning assets." (Woodford, 2001, page 4).

[10] Including, *inter alia*, the existence of nominal rigidities in the economy, the elasticity of supply, the interest-rate elasticity of investment, the interest-rate and income elasticities of money demand, the degree of openness of the economy, the exchange-rate regime, the magnitude of wealth effects, the presence of forward-looking agents and, more generally, the role played by rational expectations.

The empirical literature studying the relationship between fiscal policy and inflation has traditionally focused on the aggregate fiscal balance, without generally distinguishing between different budget items, and on specific and extreme circumstances (episodes of hyperinflation, government insolvency and monetisation of the debt).[11] Unsurprisingly, outside these episodes, only limited evidence of a relationship between fiscal deficits and inflation has been found, and even there it is restricted to emerging countries and the long-run horizon. King and Plosser (1985), for example, found no significant causality from fiscal deficits to changes in base money and inflation in the US and in another 12 countries. These results are similar to those obtained by Montiel (1989) and Dornbush, Sturzenegger and Wolf (1990) in the case of some high-inflation emerging countries. More recently, Catao and Terrones (2001) found a statistically significant long-run relationship between the ratio of government deficits to narrow money and inflation for a panel of emerging market economies. Also Fischer, Sahay and Végh (2000) found fiscal deficits causing high inflation but detected no evidence of a relationship between inflation and fiscal balances for low-inflation countries, or during low-inflation periods in the high-inflation countries.

A more disaggregated approach than the one focusing on the budget balance can, however, be followed using econometric macromodels, the documentation of which would typically include simulation of shocks to specific fiscal variables, such as various expenditure items or different tax rates. The drawback of this source of information rests on the dependency of the results not only on the specific model used, but also on the various ancillary assumptions included in the experiments. Efforts to implement comparable simulations across different econometric models have been made in the US, with the well-known NBER/NSF model comparison seminars held in the mid-seventies (Fromm and Klein, 1976) and resumed at the end of the eighties (Klein, 1991) and the Brookings Institutions conference in the late eighties (Bryant *et al.*, 1988). Similar exercises were conducted in the UK where, following the establishment in 1983 of the Economic and Social Research Council (ESRC) Macroeconomic Modelling Bureau and across almost two

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[11] See, for instance, Sargent (1982).

decades, surveys dedicated to specific issues were published on a regular basis (Church *et al.*, 2000).[12]

The results for the UK and the US, which focus on shocks to government expenditure and personal income tax, tend to show a relatively small impact on prices for both kinds in the first year. In the second year, a large impact is shown only in the 1991 US comparison exercise for the expenditure shock (results are recalled in Tables 2 and 4, along with the euro-area results). To our knowledge, such extensive comparative analyses of fiscal simulations are not available for euro-area countries – as opposed to, for instance, monetary policy simulation comparisons (see, e.g., BIS 1995, WGEM 2003).

A disaggregated approach is also followed by the recent strand of the literature that has applied VAR methods to the analysis of the effects of fiscal policy on macroeconomic variables (see Table 1). The studies included in this literature are not homogeneous, especially with reference to the approaches used to identify fiscal policy shocks (a survey of the different approaches can be found in Perotti, 2002). The studies also differ with respect to the variables included in the VAR models. As shown by Favero (2002) for the case without modelling monetary policy, omitting variables from the specification of the models may give rise to misleading results. The lack of reliable quarterly data for fiscal variables has so far limited the application of these methods to a few countries. Moreover, it calls for caution in interpreting the results, to the extent that they may depend on the interpolation methods employed.

The evidence from this literature concerning the effect of government spending shocks on prices or inflation appears mixed. For the US, Fatás and Mihov (2001) and Mountford and Uhlig (2002) show negative effects on prices after a positive government spending shock.[13] Perotti (2002) finds an initial positive impact and negative effects thereafter on the

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[12]  This article concluded the series of surveys, as unfortunately the Bureau closed on 30 September 1999.

[13]  According to Perotti (2002), these two studies implicitly assume a zero elasticity of real government spending to the price level. To assess the implications of this assumption, the author considers two polar cases and a more plausible intermediate one (with the price elasticity equal, respectively, to 0, –1 and –0.5). He shows that, under the assumption of price elasticity equal to 0, the effects of government spending on the GDP deflator after four quarters are negative in four out of the five countries he examines, though only in two cases are they significant. However, moving to the intermediate case, the values of the estimated effects increase significantly and the negative sign remains only in the case of one country (US). All effects become positive

CPI over the period 1961-2000; for the sub-period starting in 1980, the effects (albeit not significant) are instead positive after one, twelve and twenty quarters and negative after four quarters. Edelberg, Eichenbaum and Fisher (1999) find a negative effect after an initial positive effect, Neri (2001) reports no significant effects and Canzoneri, Cumby and Diba (2002) find a temporary rise in inflation after a brief decline. For other OECD countries, Perotti (2002) finds positive effects of government spending on prices in Germany, the UK and Australia, and negative, albeit small, in Canada. Marcellino (2002) reports minor and not statistically significant effects on inflation in Germany, Italy and Spain[14] and a positive and significant effect in France in the short run. Finally, Canova and Pappa (2002), which studies the effect of fiscal shocks on price dispersion in the US states and in the EU countries, find that, on average, expansionary expenditure shocks (identified as those that produce contemporaneous positive co-movements in output and deficit) increase relative prices. The effects are significant for the first two years in the case of the US states and for the first four quarters in the case of the EU countries. However, large differences exist in the shape and sign of the price responses across states and countries. In particular, for fourteen out of 45 US states, relative price responses are negative.

As regards tax shocks,[15] Mountford and Uhlig (2002) find that a net revenue shock has a negligible effect on prices in the US when controlling for the business cycle and for monetary policy shocks,[16] while in Canzoneri, Cumby and Diba (2002) the inflation

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when the elasticity of real government spending to the price level is assumed to be equal to –1. With few exceptions (and quantitatively minimal), the response at all horizons, periods examined and countries is larger when the elasticity is –0.5 than when it is 0. The results reported in the text are calculated with the former value.

[14] This non-significant effect also appears when considering separately three components of public expenditure: consumption, investment and social benefits.

[15] In the VAR studies reviewed in this paper taxes are defined, except in the case of Marcellino (2002), as total taxes minus transfers. Thus, the results are not directly comparable to those obtained in the simulation exercises presented below.

[16] They also observe a reduction in the GDP deflator in the case of a balanced budget spending shock, defined as an increase in both government revenues and expenditures in such a way that the sum of the weighted increase in revenues and expenditure is zero for each period in the four-quarter window following the shock.

response to a net tax increase is negative, although very small, after an initial, minor positive effect. Marcellino (2002) reports non-significant effects on inflation of positive tax shocks in France, Germany and Spain, while inflation significantly increases in Italy in the short run.[17] Perotti (2002) finds that, in particular in the post-1980 period, the impact of a tax shock on prices is very small, typically negative or zero, while after three years there is evidence of a positive effect in UK and Australia, although only in the latter is the effect sizeable. Finally, Canova and Pappa (2002) estimate that, on average, positive revenue shocks (identified as those that produce contemporaneous negative co-movements in output and deficit) decrease relative prices in US states and EU countries (with the effects being significant for the first two years in the case of the US states and after the seventh quarter in the case of the EU countries). Again, however, there are large differences in the shape and sign of the responses across states and countries. The results also suggest that expenditure and revenue shocks matter as a source of price dispersion, the magnitude of the effects being larger in the US than in the euro-area countries.

Overall, the studies that have applied VAR methods seem to agree on the effects on output, at least when horizons within one year are considered: the impacts are positive for demand shocks and negative for revenue shocks. On the other hand, the picture appears quite unclear as regards the impact on prices.

## 3. Design of simulations and caveats

This section provides a brief description of the simulation design, also discussing some problems of comparability across the results of the various models and some other methodological caveats.

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[17] In addition, Marcellino (2002) provides the results for four revenue components (taxes on business, taxes on households, indirect taxes and social contributions). None of them appears to have a significant effect on prices in any country.

*3.1  The common simulation design*

The four simulation exercises take the form of unanticipated shocks affecting the following budget items:

1)  Purchases of goods and services

2)  Personal income tax

3)  Indirect taxes

4)  Employers' social security contributions.

Modellers participating in the project constructed the shocks so as to deliver an *ex ante* (*i.e.*, excluding the feedback on the budget component arising from changes in the macroeconomic variables) increase in the budget component of 1 per cent of GDP in each of the year's quarters. This was done for the Eurosystem models as well as for the other two macromodels.

A number of additional simulation guidelines were followed by Eurosystem modellers, in line with the standard (counter-factual) projection environment of the Eurosystem, as already mentioned. Interest rates and exchange rates were therefore kept equal to their baseline values over the simulation horizon. Being mainly interested in fiscal shocks affecting an individual country, this assumption seems reasonable anyhow, since the shocks reviewed tend to have a one-off impact on inflation and affect individual countries, while in the case at hand – the euro area – monetary policy responds to the entire area aggregate developments. For similar reasons, fiscal rules included in the models were suspended in the experiments.[18]

*3.2  Non-Eurosystem model-specific simulation design and potential implications*

While Eurosystem modellers could fully implement the guidelines mentioned above, a few differences remained in the design of the simulations with the other two models used in

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[18]  In the case of the BE model, the fiscal rule is switched back on but only in the seventh year of the simulation.

the comparison, which then may affect comparability across results, in particular with respect to the assumptions on the nature of the shock or on interest and exchange rates.

*Duration of the shocks* – As mentioned above, we focus our analysis on the impact of fiscal shocks, and thus on the effects in the year the shock occurs. However, in order to provide some insight into the effects of fiscal shocks at longer horizons, for the Eurosystem models we discuss the results in the year following the shock as well. In these cases, the shocks are kept approximately constant in *ex ante* terms (*i.e.,* they are not reverted). For most participating models (those which are backward-looking), the design of the simulation in the following years (t+2, t+3,…) is irrelevant.[19] However, for QUEST, to name one model, this aspect is important, and the following scheme [ (+1 (t), +1 (t+1), 0 (t+2), 0 (t+3), –1 (t+4), –1 (t+5), 0  (t+i, i≥6) ] was adopted, whereby the shock lasts for two years and is followed in the fifth and sixth year of the simulation by a shock with the opposite sign. This profile renders the cumulated impact of the shock equal to zero, which in the context of a highly forward-looking model such as QUEST is a key feature, to the extent that dealing with a non-zero permanent shock would otherwise necessarily imply shifts in the steady-state, which is beyond the scope of this paper.

*Exchange rates* – the only exception to the common rule is in the QUEST model, where the dollar-euro exchange rate is endogenous, via an uncovered interest parity (UIP) condition. Again, the forward-looking features of QUEST have significant implications for exchange-rate behaviour.

*Interest rates* – In the two models outside the Eurosystem, nominal short-term interest rates were not kept equal to the baseline values. Short-term interest rates were kept as in the baseline in real terms for the OECD model, which can be viewed as a rough (backward-looking) reaction function. In QUEST, the monetary policy assumption employed was similar to a Taylor rule (inflation-forecast based) with, however, a smaller weight

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[19]   The relevance, for the results in the year of the shock, of the design of the simulation in the following years depends on the presence of forward-looking elements and the way they are incorporated. There are forward-looking elements in the BE model in financial and goods markets, in the DE model for financial variables and in the IT model for inflation expectations. These elements tend to have a very limited impact, especially since short-term interest rates and the exchange rate are kept exogenous.

on the output gap (0.25 instead of 0.5) and a larger weight on expected inflation (1.0 instead of 0.5).

To assess the consequences of the first source of heterogeneity in monetary policy modelling when comparing Eurosystem results to those from the other two models, an alternative set of simulation exercises was performed. The AWM was used along with the ES and IT models, with constant real, instead of nominal, interest rates (as done by the OECD). The results do not significantly change in terms of effects on prices. There are no significant effects on GDP in the case of shocks to purchases and direct taxes and, with respect to the first year's results, of the social contribution shock. For the indirect taxes exercise, assuming exogenous real interest rates determines a lower impact on GDP by 0.2 percentage points in the first year and by 0.5 percentage points in the second, on average. For the shock to social contributions, the effect in the second year on the GDP is lower by 0.2 percentage points.

With respect to the Taylor rule used in QUEST (a feature needed to ensure that this highly forward-looking model solves), the fact that the determinants of monetary policy refer to the entire area suggests that this may not have had a significant impact on the individual countries' results. At the same time this is, as just said, combined with a UIP condition. Turning to such a design can indeed significantly alter the results, as seen, for instance, for the euro area with the AWM (see Dieppe and Henry, 2003). The same would presumably apply to results for the largest euro-area countries, to the extent that their own domestic developments have a big weight, by construction, in the euro-area aggregates, which then may trigger some policy and exchange-rate responses at the euro-area level, thereby affecting their own response to the shock. We therefore also report some results for the euro-area as a whole using a combination of the Taylor rule and the UIP condition, to better assess the impact of such alternative assumptions on the results.

### 3.3 Additional caveats

Beyond the assumptions just discussed, a number of other elements can have an influence on the results, which may render the comparison harder to establish, even within the more harmonised set of Eurosystem results. They have to do with the details of the fiscal

modelling or, more generally, of other behavioural equations in the model. There is also the issue of possible non-linear effects at work in the economies modelled.

Comparability across models could, for example, have been increased further by adopting more detailed guidelines on the fiscal side. One issue concerns the implications of switching off the fiscal rules, *i.e.*, whether the budget item used as an instrument – in most cases direct taxes – should be kept at its baseline levels in real, in nominal or in GDP terms. Another similar issue relates to government expenditure items. In some models, these items are endogenous, while in others they are exogenous, in nominal or in real terms. As seen from the VAR survey (on the elasticity issue see Perotti, 2002), this may be the origin of some differences in the results across models.

An additional key issue regarding the inflationary impact of fiscal measures is how indirect tax rate hikes are passed through to consumer prices. Models differ substantially in this respect. Either a full and immediate pass-through is assumed[20] – as a simple accounting effect, prices being modelled in pre-tax terms – or some partial pass-through is estimated/calibrated. In this case too, a limited set of illustrative simulations has been conducted to assess the impact of such divergences.

Another connected issue is how the economy specifically reacts to VAT-only shocks, in comparison with indirect tax shocks. Simulation experiments involving only a shock to VAT were also conducted, with the aim of assessing whether models point to a non-homogeneous impact of other indirect taxes with respect to VAT. However, only three models (BE, DE and IT) were sufficiently disaggregated to allow for such a comparison. In the DE model there is no significant difference between the results of the two exercises; in the IT and BE models the other components of indirect taxes have a more limited impact on prices.

However, these specification problems should not be seen as a fundamental drawback of our exercise. It should be remembered that uniformity and consistency cannot be fully achieved, as recognised in other comparisons of this kind (e.g., Fromm and Klein, 1976, and

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[20] In the case of the BE model, the assumption of a full pass-through has been adopted on the basis of case studies and more general information on price changes.

Church *et al.*, 2000).[21] Moreover, many aspects on which assumptions are not fully comparable do not seem to affect the results significantly, especially in view of the short-term focus of the analysis.

Other sources of heterogeneity may, however, be more difficult to assess, such as those stemming from fundamental differences across models. As is often pointed out in the context of such cross-country model comparison exercises (see, e.g., Berben *et al.*, 2003), some of these differences may be due to actual diversities among countries, while others clearly reflect modellers' choices or even the availability of data. Moreover, while the size of the models is not very different, the different level of disaggregation can lead to serious comparability problems for specific shocks. This is certainly the case of results for indirect taxes, where the number of individual deflators and their match with the individual indirect tax rates is crucial. Another example concerns the results of the shock to government purchases of goods and services, as some models do not distinguish between those purchases and spending on compensation of employees.

Finally, the simulations performed in the analysis do not control for the cyclical situation of the economy. This latter *caveat* is particularly noteworthy since the cyclical position of the economy is often seen as a crucial element when analysing the impact of fiscal policy on economic activity (Hemming, Kell and Mafouz, 2002). In general, however, the models employed are close to being linear, so that such elements arguably do not have a significant bearing on the results, especially if shocks are of small magnitude. Therefore, results should be interpreted as the effects of fiscal policy on prices under "normal" cyclical circumstances. Simulation experiments involving the AWM and the IT model were performed to assess the relevance of initial conditions. In these exercises, the standard baseline simulation was replaced with one reflecting a large positive shock from external demand. For both models, the effects on prices and output of an increase in purchases of goods and services were affected only to a very limited extent by the change of baseline.

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[21] In the comparison of US models carried out in 1976, the rule explicitly adopted was "…to let model operators interpret a given set of directives as closely as possible, while recognizing that each model has some distinctive characteristics that do not always permit full compliance." (Klein, 1991, page 8).

Regardless of those necessary *caveats*, it should be noted that the aim of the study is not to compare the models *per se*, but to find out if there is a relative consensus on the channels through which budget items affect prices in the short run and on the likely quantitative effects. In this respect, the adoption of different ancillary assumptions in the design of the experiments or in the model structure may be a way, albeit obviously not systematic, of documenting the robustness of the conclusions reached.

## 4. Simulation results

In the following paragraphs, where we discuss the simulations, we mostly refer to the average and the dispersion of the results. The first indicator is the unweighted mean of the results for the five Eurosytem country-models, INTERLINK and QUEST. The mean is computed over seven results, since we include only the averages of the results for the various euro-area individual countries obtained, respectively, with the INTERLINK and QUEST models. Otherwise, a simple country-average would have given too much weight to these two (multi-country) models – and therefore to the modellers' choices embodied in them. Moreover, in order to keep the set of country-results homogeneous, we exclude the AWM from the computation. The latter model should be characterised by smaller leakages, to the extent that the euro area is comparatively less open than any of its country components. In addition, the AWM mechanically incorporates the assumption of a joint shock affecting all countries, which, due to (implicit) trade spillover mechanisms, should increase the multiplier with respect to (euro-area) single-country simulations. As for the second indicator, we indicate the minimum and the maximum result of all models, considering those of individual countries' of the multi-country models and excluding only the AWM for the reasons we have already mentioned.

### 4.1 Increase in government purchases of goods and services

The impact of government purchases on prices can be expected to occur essentially via their impact on demand, with the change in the latter affecting prices. The mechanisms at play are therefore twofold. Regarding the first stage of transmission, there is a broad

consensus in economic theory that, except in special circumstances, an increase in government purchases of goods and services expands aggregate demand in the short run. There is, however, great uncertainty over the magnitude of this impact (Perotti, 2001). Multipliers above one are usually justified by the accelerator response of investment and by a positive reaction of private consumption stemming from the additional current income generated by the shock. The multiplier becomes smaller with, *inter alia*, an increasing import content of demand and when negative reactions of forward-looking agents, affecting both consumption and investment, are allowed. As for the extent of these reactions, the following two factors are crucial: the importance of liquidity constraints and how agents' expectations about the implication for future government (tax) policy are modelled.

Likewise, there is uncertainty concerning the relation between demand and prices. While it is often considered that an increase in demand positively affects price developments, it should be pointed out that it is an open empirical issue whether prices are pro-cyclical or not (see, e.g., Kydland and Prescott, 1990 and Marchetti, 2001). These mixed results may indeed be due to the difficulty of distinguishing in practice between supply and demand shocks. In addition, a number of theoretical reasons for mark-ups being counter-cyclical have been put forth in the literature on the pricing policies of firms in oligopolistic markets (see, e.g., Rotemberg and Saloner, 1986 and Stiglitz, 1984). This, combined with the stylised fact of counter-cyclical unit labour costs, may explain a negative impact of public spending on prices. The lack of consensus on both the size and sign of the latter is confirmed by the contradictory results obtained in VAR studies (see Table 1).

This first exercise represents a standard macromodel simulation experiment, very often conducted in the context of comparison exercises. Usually, the main focus of the analysis is the measurement of the multiplier of government demand, *i.e.*, its impact on GDP. However, results for the impact on prices are often also reported, which allows us to compare our results with four similar exercises carried out in the US in two different decades, and in the UK.

For the first year (year t), the results of this experiment (see Table 2) indicate an almost negligible impact on prices, with a small dispersion of estimated values. The mean value of the impact on prices is 0.11 per cent, a value very close to the averages of US and

Table 1

# EFFECTS ON PRICES AND GDP OF GOVERNMENT
# DEMAND AND REVENUE SHOCKS IN SELECTED VAR STUDIES

| Quarters | Prices | | | | GDP | | | |
|---|---|---|---|---|---|---|---|---|
| | 1st qrt | 4th qrt | 12th qrt | 20th qrt | 1st qrt | 4th qrt | 12th qrt | 20th qrt |
| **Demand shock – US** | | | | | | | | |
| Perotti (2002) 1961-2000 | +* | – | –* | –* | +* | + | +* | +* |
| Perotti (2002) 1980-2000 | + | – | + | + | + | + | – | –* |
| Neri (2001) 1965-1996 | + | + | + | + | +* | +* | – | – |
| Fatás and Mihov (2001) 1960-1996 | –* | –* | –* | –* | +* | +* | +* | +* |
| Edelberg, Eichenbaum and Fisher (1998) 1948-1996 | +* | +* | – | | +* | +* | +* | |
| Mountford and Uhlig (2002) 1955-2000 | – | –* | –* | – | + | + | – | – |
| Canzoneri, Cumby and Diba (2002) | – | + | + | | +* | +* | + | |
| **Demand shock – Germany** | | | | | | | | |
| Perotti (2002) 1961-2000 | +* | +* | +* | +* | +* | +* | – | * |
| Perotti (2002) 1980-2000 | + | +* | +* | + | + | –* | – | – |
| Marcellino (2002) 1981-2001 | – | – | | | +* | +* | | |
| **Revenue shock – US** | | | | | | | | |
| Perotti (2002) 1961-2000 | + | – | –* | –* | –* | –* | –* | –* |
| Perotti (2002) 1980-2000 | – | –* | –* | – | –* | – | * | – |
| Neri (2001) 1965-1996 | –* | –* | –* | –* | –* | –* | –* | –* |
| Mountford and Uhlig (2002) | + | + | – | – | –* | –* | –* | – |
| Canzoneri, Cumby and Diba (2002) | + | – | – | | –* | –* | –* | |
| **Revenue shock – Germany** | | | | | | | | |
| Perotti (2002) 1961-2000 | – | +* | + | – | –* | –* | –* | – |
| Perotti (2002) 1980-2000 | –* | – | –* | – | + | –* | – | –* |
| Marcellino (2002) 1981-2001 | + | + | | | – | – | | |

* The value 0 is outside the region between the two one-standard error bands.

**Table 2**

**EFFECTS IN THE FIRST AND SECOND YEAR OF AN INCREASE IN PURCHASES
OF GOODS AND SERVICES AMOUNTING TO 1% OF GDP**
(percentage points)

| Year | Prices* | | GDP | |
|---|---|---|---|---|
| | t | t+1 | t | t+1 |
| **Individual countries** | | | | |
| *Belgium* (National Bank of Belgium model) | 0.10 | 0.29 | 0.87 | 0.50 |
| *Belgium (QUEST)* | *0.10* | | *0.47* | |
| *France (INTERLINK)* | *0.2* | | *0.6* | |
| *France (QUEST)* | *0.14* | | *0.66* | |
| *Germany* (Deutsche Bundesbank model) | 0.04 | 0.17 | 1.18 | 1.07 |
| *Germany (INTERLINK)* | *0.2* | | *0.9* | |
| *Germany (QUEST)* | *0.16* | | *0.65* | |
| *Italy* (Banca d'Italia model) | 0.06 | 0.33 | 0.98 | 1.44 |
| *Italy (INTERLINK)* | *0.2* | | *0.7* | |
| *Italy (QUEST)* | *0.12* | | *0.66* | |
| *Portugal* (Banco de Portugal model) | 0.07 | 0.18 | 1.23 | 1.49 |
| *Portugal (QUEST)* | *0.16* | | *0.48* | |
| *Spain* (Banco de España model) | 0.2 | 0.62 | 1.22 | 1.46 |
| *Spain (QUEST)* | *0.08* | | *0.67* | |
| ***Average*** | ***0.11*** [1] | ***0.32*** [2] | ***0.97*** [1] | ***1.19*** [2] |
| *Extreme values* | *(0.04; 0.2)* [1] | *(0.17; 0.62)* [2] | *(0.47; 1.23)* [1] | *(0.50; 1.49)* [2] |
| **Euro Area** | | | | |
| *Area-Wide Model* | *0.16* | *0.56* | *1.05* | *1.62* |
| *INTERLINK* | *0.20* | | *1.00* | |
| UK models (Church *et al.*, 2000)[3] **Average** | **0.10** | **0.08** | **0.8** | **0.5** |
| *Extreme values* | *(–0.6; 0.9)* | *(–2.6; 2.0)* | *(0.5; 1.1)* | *(0.2; 0.9)* |
| US models (Fromm and Klein, 1976)[4] **Average** | **0.22** | **0.53** | **1.73** | **2.22** |
| *Extreme values* | *(–0.2; 1.2)* | *(–0.3; 1.8)* | *(1.6; 1.9)* | *(1.3; 2.8)* |
| US models (Bryant *et al.*, 1988)[5] **Average** | **0.04** | **0.31** | **1.27** | **1.16** |
| *Range* | *(0.6)* | *(1.84)* | *(2.0)* | *(1.75)* |
| US models (Adams and Klein, 1991)[6] **Average** | **0.22** | **1.11** | **1.87** | **2.17** |
| *Extreme values* | *(–0.09; 0.29)* | *(0.2;1.41)* | *(1.1; 2.4)* | *(1.4; 4.4)* |

* Consumer price index.
(1) Simple average of seven results: five results from the NCB models; for QUEST and INTERLINK models, simple mean of the results respectively reported for the individual countries. Extreme values of all results concerning individual countries. – (2) Simple mean and extreme values of the results from the NCB models. – (3) Average and extreme values of the reported results for the five models examined. Results for year t+1 are obtained by interpolation of results for year t and year t+2. Monetary policy: inflation targeting with interest rates as instrument. – (4) Shock to non-defence spending (including compensation of public employees). Average and extreme values of the reported results for the six quarterly models examined (for the Wharton model, the standard specification is used). Interest rate kept at its base path. Price index: GNP deflator – (5) Shock to real government purchases. Average and range of the twelve models examined. Monetary policy: money aggregates unchanged in US and other OECD countries. – (6) Shock to defence spending. Reported average and extreme values of the reported results for the eight models examined. Short-term interest rate kept at its base path. Price index: GNP deflator.

UK comparisons and to the results of the models referring to the whole euro area. The range of results across models is also strikingly small and much lower than that observed in the other reported model comparisons.[22] The lowest value is 0.04 per cent for Germany on the basis of the DE model, and the highest 0.2 per cent on the basis of the INTERLINK for any of the three countries considered (Italy, France, Germany) and for Spain on the basis of the ES model. The results indicate that the large uncertainty over the size of the impact on output (see below) does not carry over to prices. The models involved confirm the standard assumption of prices being pro-cyclical. In the models, this feature is generally obtained via output gap terms. This feature is also shown in the averages of the UK and US models, but does not necessarily hold for the individual models considered in the reported comparison studies. Results also show a consensus on the small quantitative relevance of this channel in the first year.

The results that are available for the second year show a significant increase in the impact on prices. In the case of ES and AWM, the effect is particularly large (0.6 per cent) and is consistent with a larger-than-average impact on output. Overall, the results show that the impact on prices takes some time to materialise fully and is therefore characterised by longer lags and/or by less important offsetting mechanisms than those relative to the impact on GDP. The same feature is generally shown in the results for the UK and the US. The only exception is Church *et al.* (2000), where the price effect remains on average about the same in the second year. This result, however, is driven by just one of the five models involved, for which both the price and the output effects are negative in year two. Chart 2 provides some illustration of how the extension of the simulation horizon can result in substantial price hikes in the example of ES, which is contrasted with that for BE where, overall, the modelled economy appears more stable.

Concerning the impact on output, the mean value multiplier for the first year – close to unity – is slightly higher than the one obtained in the 2000 UK model comparison (0.8 per

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[22] This may reflect the greater homogeneity of the models. The low dispersion of results can be appreciated comparing it, for instance, with the 1.2 per cent confidence interval indicated in the June 2002 Eurosystem staff projections for the HICP of the following year (ECB, 2002). The range, which reflects the uncertainty when forecasting price developments, is based on the average absolute difference between actual outcomes and past projections by euro-area central banks.

cent). The difference can be explained in part by the fact that, in the latter, the underlying monetary policy assumption is more contractionary. The average impact multiplier is, instead, lower than in the older results for US models. This may be partly due to the greater openness of the individual European countries. It may also reflect changes in the parameter estimates, in line with empirical findings that show that the effects of fiscal policy on GDP have become weaker in recent decades (see, e.g., Perotti, 2002). Finally, it should be borne in mind that modellers also presumably adjust their own tools to "common knowledge" and recognised stylised facts which, in the case at hand, may simply reflect increasing doubts about the Keynesian (vs. Ricardian) effects of fiscal expansion policies.

In our comparisons there is nonetheless a significant dispersion of the values of the impact multiplier. The lowest values, from 0.5 to 0.9, are obtained with models that allow for the presence of forward-looking agents (BE, INTERLINK and QUEST models – the latter also employing a Taylor rule). In the case of QUEST there is almost no positive response of consumption, whereas investment decreases – because of the expected rise in interest rates. Contrary to what was found for prices, the size of the range is not lower than that observed in previous model comparisons. The results of INTERLINK for the whole area are, as expected, above those for individual countries, reflecting the reduction in the import leakages, as is also seen in the AWM results. The results for the second year indicate a slight increase of the multiplier to 1.2, with quite varied results across models there as well, reflecting similar differences to those mentioned for the first year, the lowest impact being for BE and the highest for the AWM. The comparison with the other studies shows the same pattern as for the first year, with euro-area results between the UK and the US ones. See again Chart 2 for longer-run simulations also involving the ES model.

All models, including those reviewed in the US and UK comparisons, agree on the sign of the impact multiplier. This uniformity should not be considered a rejection of the results reported in the literature on non-Keynesian effects (*e.g.,* Giavazzi and Pagano, 1990, and Alesina and Perotti, 1997a). In this literature, a crucial role is played by expectations, interest-rate risk premia and credibility, factors which do not play a fundamental role in most of the models examined in this paper and are further limited by the simulation set-up.

The results can be affected by a number of specification choices, as can be seen by looking at the results of alternative simulations carried out using the same model. For

illustration purposes we simulated the AWM under different environments, reflecting a range of possible specifications for key behavioural decisions, such as for consumption, investment or interest rates. Table 3 presents the results for the following configurations of the AWM: basic forecast version (as used elsewhere in this paper), Ricardian consumers (public deficit and debt are entirely removed from income and wealth), forward-looking investors (50 per cent of the accelerator term is based on model-consistent one-year ahead GDP) and forward-looking consumers (50 per cent of income and total wealth are model-consistent one-year ahead). In addition, results are also provided for a model where short-term interest rates are endogenously determined according to the so-called Taylor rule and the nominal exchange rate by the uncovered interest parity (UIP) condition – which is very close to the QUEST simulation environment. Another element (not reported in the table) with non-negligible implications is the extent to which corporate sector profits are distributed to consumers. With all profits going each quarter to households – instead of only 40 per cent – the corresponding multipliers and price effects would be about 10 and 20 per cent stronger in years one and two.

Regardless of the specific aspects of each of the illustrative simulations reported, the following points can be made. First, unless monetary policy is active, results for prices for the first two years are not very much affected by changes in the simulation environment, whereas the Keynesian multiplier seems to vary more across model specifications. Second, the strongest impact on the multiplier is seen when consumers consider neither public deficit nor debt as income or wealth, respectively (Ricardian consumers' case). Third, in the absence of a monetary policy reaction, the multiplier remains under unity over the whole simulation horizon only when both Ricardian and forward-looking features are jointly introduced.

Fourth, with monetary policy reacting to the output and the inflation gaps, the price effect can be virtually zero, due also to the implied appreciation following the monetary policy response.

This analysis shows how a specific combination of additional features can lead to multipliers that are permanently lower than unity. It does not exclude, however, that some further negative impact on activity could arise in the longer run. Some of the usual additional negative effects of fiscal expansion could stem from a likely increase in long-term real

Table 3

**AWM SIMULATIONS OF A PUBLIC EXPENDITURE SHOCK UNDER A
VARIETY OF SIMULATION ENVIRONMENTS**

| Alternative specifications* | Prices | | | GDP | | |
|---|---|---|---|---|---|---|
| | t | t+1 | t+2 | t | t+1 | t+2 |
| BFV: basic forecast version | 0.16 | 0.55 | 1.04 | 1.04 | 1.53 | 1.57 |
| RC: Ricardian consumers | 0.15 | 0.46 | 0.81 | 0.93 | 1.17 | 1.09 |
| FLI: forward-looking investment | 0.15 | 0.51 | 0.96 | 0.97 | 1.39 | 1.42 |
| FLC: forward-looking consumption | 0.15 | 0.48 | 0.92 | 0.95 | 1.32 | 1.41 |
| RC+FLC+FLI | 0.13 | 0.38 | 0.67 | 0.78 | 0.94 | 0.85 |
| RC+FLC+FLI +monetary policy +UIP | –0.08 | –0.04 | 0.10 | 0.66 | 0.57 | 0.33 |

* All results are in percentage deviation from baseline levels. All simulations are with exogenous real interest rates, to facilitate comparison with the last simulation reported, *i.e.*, with monetary policy as a Taylor rule.

interest rates, due to the pressure created by the additional spending by consumers. This would be the case in an environment with overlapping generations rather than dynasties, which then reduces savings and investment (as documented in model simulations reported in Faruqee *et al.*, 1997). Moreover, other channels, involving asset prices and wealth valuation, which may also further reduce the multiplier, have not been investigated in this set of simulations.

*4.2 Increase in the personal income tax*

There are two main theoretical channels linking an increase in personal income tax to price developments. The first channel focuses on changes in demand determined by variations in household income. The rise in personal income tax leads to lower household disposable income and to a reduction in real private consumption – with again great uncertainty as to the impact. In determining the latter, assumptions on households are crucial, even more than in the first exercise, to the extent that the shock this time affects income directly rather than domestic demand globally. As expected from textbook macroeconomic analysis, the values of the estimated effects of the direct tax changes are lower than the spending multipliers, so that the simulation results are expected to be similar – with an opposite sign – to the ones just reported, albeit of lower magnitude. As already discussed in the previous section, the quantitative relevance of the final impact on prices via the demand channel may be very limited, at least in the short run.

The second channel reflects the process of wage bargaining. An increase in direct taxes expands the wedge between the cost of labour for firms (which is unaffected) and the workers' take-home wage (which is reduced). Workers may react by demanding higher wages, leading to higher costs and to a reduction in the demand for labour.[23] Higher costs would then lead to higher prices. The relevance of this channel depends on the extent to which direct tax hikes are shifted onto real labour costs, which is in turn closely related to labour market flexibility. In particular, institutional factors of the labour market, such as employment protection legislation and unions and wage negotiation mechanisms, are usually found to be empirically relevant in explaining tax shifting. The models employed in this paper do not include the tax wedge among the short-run determinants of wages. The only limited exceptions refer to the social security contribution component of the wedge (see Section 4.4 below on this). It may be noted that the almost complete absence of this channel is not in contrast with the well-known empirical analysis of Daveri and Tabellini (2000).

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[23] According to standard theory, if labour markets are competitive, a small elasticity of the individual labour supply, as generally found empirically, implies that the burden of a tax on labour is borne almost entirely by the worker. But if workers are organised in monopolistic unions, they can succeed in shifting the burden of labour taxes onto firms (Daveri and Tabellini, 2000).

This study provides evidence of the existence of a partial shifting of labour taxes onto wages only in the medium term, using five-year averages of the variables, and it is therefore compatible with the absence of significant short-term effects.

As regards the first year, the results (see Table 4) show a negligible impact on prices, with a small dispersion of estimated values. The mean value of the impact on prices is almost zero and negative, very close to the average results for the UK and US models. The results we obtain are not surprising, as the impact through the demand channel is necessarily only a fraction of that, already small, caused by a public expenditure shock, and the second above-mentioned channel, at least in the short-run, is not embodied in the models reviewed.

The results for the second year tend to show a limited impact on prices (between –0.2 and –0.04 per cent), albeit larger than in the first year. Only the ES model shows a non-negligible negative impact on prices (–0.3 per cent), associated with a particularly large contraction of GDP. This can be explained by the relatively high elasticity of private consumption to disposable income. Overall, the results are not significantly different from those found for the UK and the US.

The mean value of the impact on output in our comparison is –0.33 per cent in the first year and –0.66 per cent in the second year. In both years, this is slightly stronger than the average of the UK results, but much lower than that for the US. As in the previous experiment, the dispersion of the impact on output across models is larger than that of the impact on prices. As in the previous experiment (concerning a shock to government purchases of goods and services) the lowest values (in absolute terms) are generally obtained with models that allow for the presence of forward-looking agents (BE, INTERLINK and QUEST models).

### 4.3 Increase in indirect taxes

Reflecting the widespread practice of bargaining on the basis of prices net of VAT and other indirect taxes, the assumption of an immediate pass-through to prices of changes in indirect tax rates is common among forecasters, but is not embodied in all the models we

Table 4

## EFFECTS IN THE FIRST AND SECOND YEAR OF AN INCREASE
## IN PERSONAL INCOME TAX AMOUNTING TO 1% OF GDP
(percentage points)

| Year | Prices* | | GDP | |
|---|---|---|---|---|
| | t | t+1 | t | t+1 |
| **Individual countries** | | | | |
| *Belgium* (National Bank of Belgium model) | –0.01 | –0.07 | –0.15 | –0.23 |
| *Belgium (QUEST)* | *0.0* | | *–0.14* | |
| *France (INTERLINK)* | *0.0* | | *–0.2* | |
| *France (QUEST)* | *0.00* | | *–0.22* | |
| *Germany* (Deutsche Bundesbank model) | –0.04 | –0.09 | –0.62 | –0.91 |
| *Germany (INTERLINK)* | *–0.10* | | *–0.5* | |
| *Germany (QUEST)* | *0.00* | | *–0.22* | |
| *Italy* (Banca d'Italia model) | –0.01 | –0.04 | –0.13 | –0.45 |
| *Italy (INTERLINK)* | *0.0* | | *–0.2* | |
| *Italy (QUEST)* | *–0.01* | | *–0.21* | |
| *Portugal* (Banco de Portugal model) | –0.02 | –0.07 | –0.39 | –0.67 |
| *Portugal (QUEST)* | *–0.02* | | *–0.15* | |
| *Spain* (Banco de España model) | –0.07 | –0.31 | –0.50 | –1.02 |
| *Spain (QUEST)* | *–0.01* | | *–0.19* | |
| ***Average*** | ***–0.03***[1] | ***–0.12***[2] | ***–0.33***[1] | ***–0.66***[2] |
| *Extreme values* | *(–0.1; 0.0)*[1] | *(–0.31;–0.04)*[2] | *(–0.62;–0.13)*[1] | *(–1,02;–0.23)*[2] |
| **Euro Area** | | | | |
| *Area-Wide Model* | *–0.05* | *–0.20* | *–0.34* | *–0.63* |
| *INTERLINK* | *–0.1* | | *–0.5* | |
| UK models (Church *et al.*, 2000)[3] ***Average*** | **0.04** | **0.07** | **–0.17** | **–0.25** |
| *Extreme values* | *(–0.04; 0.10)* | *(–0.1; 0.33)* | *(–0.32; –0.01)* | *(0; –0.4)* |
| US models ***Average*** | **0.02** | **–0.26** | **–1.01** | **–1.44** |
| (Fromm and Klein, 1976)[4] *Extreme values* | *(–0.1; 0.2)* | *(–0.5; 0.2)* | *(–1.3; –0.6)* | *(–1.8; –1.1)* |

* Consumer price index.
(1) Simple average of seven results: five results from the NCB models; for QUEST and INTERLINK models, simple mean of the results respectively reported for the individual countries. Extreme values of all results concerning individual countries. – (2) Simple mean and extreme values of the results from the NCB models. – (3) The results reported in Church *et al.* (2000) refer to a 2% increase in the "basic income tax rate"; they have been rescaled to ensure comparability. Extreme values of the reported results for the five models examined. Results for year t+1 are obtained by interpolation of the results reported for year t and year t+2. Monetary policy: inflation targeting with interest rates as instrument. – (4) Average and extreme values of the reported results for the seven models examined (for the Wharton model the standard specification is used). Monetary policy: as in baseline. Price index: GNP deflator.

employ. In particular, for the AWM, ES, IT, PT, and Interlink Italy models, the pricing policies of firms temporarily reduce the mechanical impact of indirect taxes on prices, which do not increase by the full amount of the change in VAT and excise rates.[24] This, in turn, may have an impact on GDP, to the extent that firms will possibly invest less, having to share with consumers the burden of increased taxes and therefore being more liquidity constrained.

Wage bargaining or indexation mechanisms may reinforce the direct impact of a change in indirect taxes.[25] According to standard labour market analyses, workers care about their real wage and assess it using the consumer price index, while firms focus on real labour costs, deflated using the price of production index. A positive change in indirect taxes, therefore, reduces the value of the wage for workers but not the labour cost as perceived by firms. This may lead to a higher level of equilibrium for wages. However, as already mentioned, none of the models participating in the comparison includes the indirect tax wedge among the short-run determinants of wages.

For the first year, the mean value of the impact on price developments is 1.19 per cent. While there is a certain dispersion of results (see Table 5), it reflects almost entirely the different treatment of the pass-through of indirect taxes. Most of the remaining differences reflect the dispersion across countries in the value of the ratio between consumption (government and private) and GDP and in the amount of VAT and other indirect taxes that do not apply to consumption goods (in principle, VAT does not apply to capital goods, it is usually levied on private construction investment). The indexation of wages to prices in Belgium also explains the high value of the impact in that country, which is consistently shown in both the QUEST and the BE model.

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[24] In the IT model, the equation determining the production (*i.e.*, net of indirect taxes) deflator for non-durable consumption goods includes VAT and other excise rates among regressors and the estimated coefficient has a negative sign. This estimated offsetting mechanism slowly vanishes and in the eighth quarter the impact is close to that consistent with full pass-through. In the AWM the pass through after one year on consumer prices is 80 per cent with a full indexation of GDP deflator at market prices (*i.e.*, including indirect taxes) in the longer run. At the same time, there is no differentiated impact of taxes and pre-tax GDP deflator on the HICP.

[25] The role of the tax wedge in wage bargaining has also been discussed above with reference to direct taxes.

Table 5

**EFFECTS IN THE FIRST AND SECOND YEAR OF AN INCREASE
IN INDIRECT TAXES AMOUNTING TO 1% OF GDP**
(percentage points)

| | Prices* | | GDP | |
|---|---|---|---|---|
| Year | T | T+1 | T | t+1 |
| **Individual countries** | | | | |
| *Belgium* (National Bank of Belgium model) | 1.60 | 1.99 | 0.02 | 0.00 |
| *Belgium (QUEST)* | *1.66* | | *−0.32* | |
| *France (INTERLINK)* | *1.40* | | *−0.50* | |
| *France (QUEST)* | *1.50* | | *−0.55* | |
| *Germany* (Deutsche Bundesbank model) | 1.17 | 1.2 | −0.55 | −0.53 |
| *Germany (INTERLINK)* | *1.30* | | *−1.40* | |
| *Germany (QUEST)* | *1.49* | | *−0.54* | |
| *Italy* (Banca d'Italia model) | <u>0.79</u> | <u>1.39</u> | <u>−0.33</u> | <u>−0.52</u> |
| *Italy (INTERLINK)* | <u>*0.8*</u> | | <u>*−0.30*</u> | |
| *Italy (QUEST)* | *1.38* | | *−0.54* | |
| *Portugal* (Banco de Portugal model) | <u>1.10</u> | <u>1.59</u> | <u>−0.17</u> | <u>−0.41</u> |
| *Portugal (QUEST)* | *1.24* | | *−0.36* | |
| *Spain* (Banco de España model) | <u>1.05</u> | <u>1.46</u> | <u>−0.20</u> | <u>−0.65</u> |
| *Spain (QUEST)* | *1.44* | | *−0.54* | |
| ***Average*** | ***1.19*** [1] | ***1.53*** [2] | ***−0.35*** [1] | ***−0.42*** [2] |
| *Extreme values* | *(0.79;1.66)* [1] | *(1.2; 1.99)* [2] | *(−0.55; 0.02)* [1] | *(−0.65; 0.0)* [2] |
| **Euro Area** | | | | |
| *Area-Wide Model* | <u>*0.85*</u> | <u>*1.17*</u> | <u>*−0.28*</u> | <u>*−0.76*</u> |
| *INTERLINK* | *1.2* | | *−0.9* | |

* Consumer price index.
When underlined, results indicate that there is a partial pass-through in the model.
(1) Simple average of seven results: five results from the NCB models; for QUEST and INTERLINK models, simple mean of the results respectively reported for the individual countries. Extreme values of all results concerning individual countries. – (2) Simple mean and extreme values of the results from the NCB models.

The key importance of the extent to which there is a partial versus a total pass-through is illustrated by two additional experiments, which produce quantitatively similar results. The first, performed with the IT model, is one in which the temporary reaction of net prices is excluded and the full pass-through re-established. With this assumption, the impact on prices increases from 0.79 (the lowest across the results) to 1.2 per cent, close to the average of the models that embody a full pass-through (1.3 per cent, excluding Belgium). A second type of experiment is to estimate consumer price equations in which the impact of indirect taxes and pre-tax prices is not constrained to be the same, assessing thereafter the impact on the results. Using the AWM, the unconstrained estimated parameters are consistent with a pass-through of 60 per cent after one year (versus 80 per cent in the original specification where the after-tax GDP deflator determines the HICP). This reduction in the pass-through leads to a similar decrease in the impact on prices, *i.e.* also of about a third.

The results for the second year of the simulations show a significant increase in the impact on prices. The increase is particularly strong for models which embody a temporary mechanism partially offsetting the full pass-through. As the impact of this mechanism vanishes, the dispersion across models diminishes. The only large outlier is the result for Belgium (where only the results for the BE model are available), in which a wage-price spiral is fuelled by wage indexation.

The mean value of the impact on GDP in our comparison is –0.35 per cent in the first year, with a significant dispersion of values across countries and models, even if the results of the INTERLINK model for Germany are excluded. All simulations show a negative impact on output except the one conducted using the BE model, which has a nil impact both in the first and in the second year. This counter-intuitive result is not confirmed by the results of QUEST for Belgium, which are in line with those of the other countries. In the BE model, the standard demand channels are relatively weak (the decline in consumption is less than 0.1 per cent) and, moreover, are offset in the first two years by the increase in the investment of forward-looking firms, which react to the upward shift in relative labour costs.

The impact on GDP for models without a full pass-through is relatively modest, ranging between 0.1 and 0.3. This presumably reflects the fact that part of the burden is temporarily borne by firms, generally considered less liquidity-constrained than consumers.

In the second year, as for prices, the differences between the two types of models diminish significantly. Excluding the results of INTERLINK for Germany, the dispersion of the results concerning the impact of output seems comparable to that regarding the impact on prices.

### 4.4  Increase in employers' social security contributions

An increase in the social security contributions of employers (SSCE) raises firms' labour costs and should lead to higher prices and, via the income/demand channel, lower output and employment. The lower wage income due to the fall in employment (directly and indirectly, as unemployment affects wage bargaining) has a negative impact on real disposable income and, through the demand channel, leads to a fall in prices, partly offsetting the impact of the increase in labour costs.

An additional channel which, in principle, could partly reduce the rise in prices, reflects the process of wage bargaining. As discussed for the exercise involving direct taxes, changes in the labour-tax wedge may affect firms' and workers' decisions. In particular, an increase in social security contributions expands the wedge between the cost of labour for firms (which is higher) and workers' take-home wage (which is unaffected). Firms may react by offering lower wages. However, most models employed in this paper do not include social security contributions among the short-run determinants of wages. The only exceptions are the BE model and the AWM.[26]

The results (see Table 6) show a considerable impact on prices, with a significant but moderate dispersion across countries. The mean value of the impact on price developments is 0.41 per cent in the first year and 0.85 per cent in the second year. The extreme values in the first year are shown by the ES model (0.1 per cent) – where wages are mostly backward-looking – and INTERLINK for Germany (0.8 per cent). Results for the second

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[26]  In the BE model a "theoretical" wage-setting equation which includes the implicit rate of social security contributions among its exogenous variables has been estimated. However, in the usual configuration of the model (and also in that used in the case of these simulations) wages are exogenous in real terms, reflecting the "wage norm" stemming from an agreement of the "social partners", which defines real wage increases for a two-year period. In the AWM there is a (calibrated) impact of social contributions on wage formation in the short run.

Table 6

**EFFECTS IN THE FIRST AND SECOND YEARS OF AN INCREASE IN SOCIAL
SECURITY CONTRIBUTIONS OF EMPLOYERS AMOUNTING TO 1% OF GDP**
**(**percentage points)

| | Prices* | | GDP | |
|---|---|---|---|---|
| Year | t | t+1 | t | t+1 |
| **Individual countries** | | | | |
| *Belgium* (National Bank of Belgium model) | 0.27 | 1.02 | –0.01 | –0.18 |
| *France (INTERLINK)* | *0.70* | | *–0.20* | |
| *Germany* (Deutsche Bundesbank model) | 0.24 | 0.51 | –0.51 | –0.88 |
| *Germany (INTERLINK)* | *0.80* | | *–1.20* | |
| *Italy* (Banca d'Italia model) | 0.64 | 1.21 | –0.09 | –0.51 |
| *Italy (INTERLINK)* | *0.20* | | *–0.10* | |
| *Portugal* (Banco de Portugal model) | 0.67 | 0.90 | –0.18 | –0.44 |
| *Spain* (Banco de España model) | 0.10 | 0.62 | –0.52 | –1.03 |
| *Average* | *0.41* [1] | *0.85* [2] | *–0.30* [1] | *–0.61* [2] |
| *Extreme values* | *(0.1; 0.8)* [1] | *(0.51; 1.21)* [2] | *(–1.2; –0.01)* [1] | *(–1.03; –0.18)* [2] |
| **Euro Area** | | | | |
| *Area-Wide Model* | *0.32* | *0.49* | *–0.34* | *–0.62* |
| *INTERLINK* | *0.7* | | *–0.6* | |

* Consumer price index.
(1) Simple average of 6 results: 5 results from the NCB models; for INTERLINK, simple mean of the results reported for the individual countries. Extreme values of all results concerning individual countries. –
(2) Simple mean and extreme values of the results from the NCB models.

year are quite varied across the models, with, in particular, a weak response for the AWM, presumably due the above-mentioned effects on households' wages.

The mean value of the impact on output is –0.30% in the first year. Excluding the extremely large negative estimate for INTERLINK Germany (–1.2 per cent), results range between –0.5 per cent for the DE and ES models and –0.01 per cent with the BE model. Excluding the outlier, therefore, the dispersion compares to that obtained for prices. The effect on the second year reaches –0.61 per cent on average.

## 5. Summary and conclusions

We have conducted a comparative review of the short-run impact on prices of a number of fiscal policy shocks, using a variety of macroeconometric models for euro-area countries as well as for the euro area as a whole, with particular emphasis on models held within the Eurosystem of central banks. We have also illustrated how some (controlled) changes to the models explain why results sometimes differed substantially – in particular for the government expenditure on goods and services and indirect tax shocks – with a view to going beyond reporting multipliers.

The main results from the exercise are the following, taking in turn each of the reported experiments.

First, the impact of a *change in government expenditure* on prices is limited in the short term. The result confirms those of similar model comparisons carried out in the UK and the US and is consistent with the small or non-significant effects found by most of the recent VAR-based studies. From additional simulations we conducted, there is also evidence that model design would primarily impact on the results for activity – *i.e.*, on the Keynesian multiplier – without major implications for price effects.

Second, the impact on prices of a *change in direct taxes on households* also appears to be negligible. This reflects the small quantitative relevance (see previous exercise) of the demand channel, activated by the effects of direct taxes on disposable income, and the absence of direct taxes among the short-run determinants of wages in all models.

Third, *indirect taxes* have a relatively large impact on prices, but the results are relatively dispersed. This variability depends mainly on the differences across models of the degree of pass-through to final prices of changes in indirect taxes.

Fourth, *employers' social security contributions* should not be overlooked when assessing inflation, as all models agree that they have a significant impact on price developments. The latter, however, seem to depend on the extent to which wage bargaining is affected by such measures.

More generally, an interesting element is that the dispersion of the results we have reported is relatively limited, especially for the first two shocks, including in comparison with previous similar exercises. In addition, the results obtained for the year following the shock show that the effect on prices usually takes some time to materialise fully. This applies particularly to the shocks to public consumption, the effects of which, in some countries, become large only in the second year. This is in line with the results obtained for the UK and the US. The effects on prices also appear to be even larger at further horizons, which, in turn, raises the issue of monetary policy reaction, a feature not incorporated in the context of this exercise, which is focused on short-term responses conditional on a no-policy-change assumption.

# Appendix

## Main features of the econometric models involved

Our comparison exercise covers the results of simulations with eight econometric models. We focus mostly on the six used within the Eurosystem of central banks. Five are models for euro-area countries – held at the National Bank of Belgium (denoted BE), Deutsche Bundesbank (DE), Banca d'Italia (IT), Banco de Portugal (PT) and Banco de España (ES). The sixth is a model for the euro area as a whole (Area-Wide Model, AWM) used at the ECB. The last two models (INTERLINK and QUEST), used as additional references, have been developed at the OECD and the European Commission respectively. Although the theoretical underpinnings of these models and their purposes are very different, they share some common features. These are described below and the main differences are also highlighted.

Four of the models are single-country models (BE, IT, PT and ES). Three others are multi-country models (DE, OECD, QUEST), allowing shocks to individual countries or the whole area to be examined. However, for the DE model only results for Germany have been reported (as for other central banks). Finally, the AWM treats the euro area as a single economy and does not provide single-country results. Single-country models, except that of IT, are relatively small, with between 15 and 30 estimated behavioural equations, while the multi-country models and the IT model all have a much larger number of estimated equations. Moreover, all the models use quarterly data, except that of PT, which is based on annual data.

In all these models, the short-run behaviour is demand-determined, while a vertical supply curve determines long-run output. The latter is driven in all cases by a Cobb-Douglas production function[27] with two productive factors (labour and capital) and exogenous technological progress or a total factor productivity term, the measure of labour supply including a definition of the NAIRU. In the short run, with sluggish prices and wages, the

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[27] Private sector GDP is given through a nested CES and Cobb Douglas production function in the QUEST model. A Cobb-Douglas function with oil as an intermediate factor is employed in the PT model.

level of demand (and, therefore, output) may differ from its long-run level, starting a process of price and wage adjustment that drives the model back to its long-run equilibrium.

One of the key differences between the models, with possibly important consequences for the results of model simulations, refers to the treatment of expectations. The ES and PT models do not include any forward-looking element. Although many of the other Eurosystem models can include forward-looking behaviour in, for example, the formation of exchange rates or long-term interest rates, these features were not used in this exercise, given the specific simulation environment retained. Finally, the BE, OECD and QUEST models include further forward-looking elements in a number of other variables, including private consumption, labour market and price variables (other models as well, such as the AWM and the IT model, can also incorporate such features, although they were not included in the version used for this exercise). In most cases, however, the impact of these differences is expected to be limited in the context of such short-run simulations. For robustness purposes, in the main text we provide some illustration of the effects of more forward-lookingness, particularly in consumption and investment, when dealing with Ricardian effects associated with a public expenditure shock.

As regards the government sector, the fiscal variables typically include 6-7 expenditure categories (2-4 of them exogenous) and 4-8 revenue items (1-2 exogenous). Exceptions are the IT and PT models, which offer a higher degree of disaggregation (13 and 17 expenditure categories and 11 and 16 revenue items, respectively). All models, except those of PT and IT, include a fiscal rule to ensure fiscal solvency in the long run, but in none of the cases has this rule been used, given the chosen simulation environment.

Monetary aggregates play no role in the determination of prices and output except in the case of the DE model, where M3 influences the determination of the long-run price level. In most models there is a range of options to close the model on the monetary side by providing a nominal anchor; quite often a Taylor rule is used. Again, these were not used in the context of this set of simulations, at least for all Eurosystem models.

As regards the main determinants of the various domestic demand components, private consumption is mainly determined by disposable income and wealth in all the models except the PT model, which does not include wealth. Most models also include interest rates as a

determinant of consumption (AWM, ES, DE, IT, PT and QUEST), while only a few of them incorporate the unemployment rate as an additional determinant (AWM, BE and PT). Finally, the BE and the QUEST models incorporate a forward-looking income variable as a long-term determinant, but explicitly allow for liquidity constrained consumers. Investment demand, meanwhile, is mainly determined by output and the user cost of capital, although most of the models distinguish between different types of investment, including public investment, generally an exogenous variable.
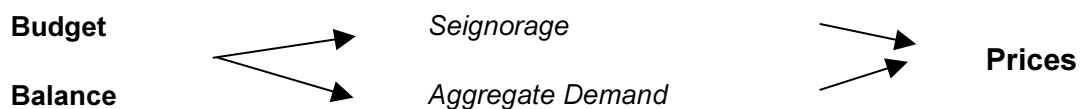
As regards external demand, world demand and competitiveness are included as long-run determinants of export volumes in all models, while final demand and competitiveness are the main determinants of import volumes. In addition, the BE and IT models include the output gap or capacity utilisation as an additional short-run determinant of import and export volumes.

As for the labour market, output is the main long-term determinant of employment in all models, along with some measure of relative labour cost.[28] Prices, productivity and unemployment are included in all the models as determinants of wages. Two main frameworks are behind the determination of wages, either a Phillips curve (AWM, PT, IT) or a wage-bargaining framework (BE, ES, OECD). In the AWM there is a (calibrated) impact of social contributions on wage formation. In the case of the QUEST Belgian and Spanish sub-models, the tax wedge also has an impact on wages as a long-run determinant, but no short-run effect. Wages are further determined by the reservation wage and vacancy cost in the QUEST model.
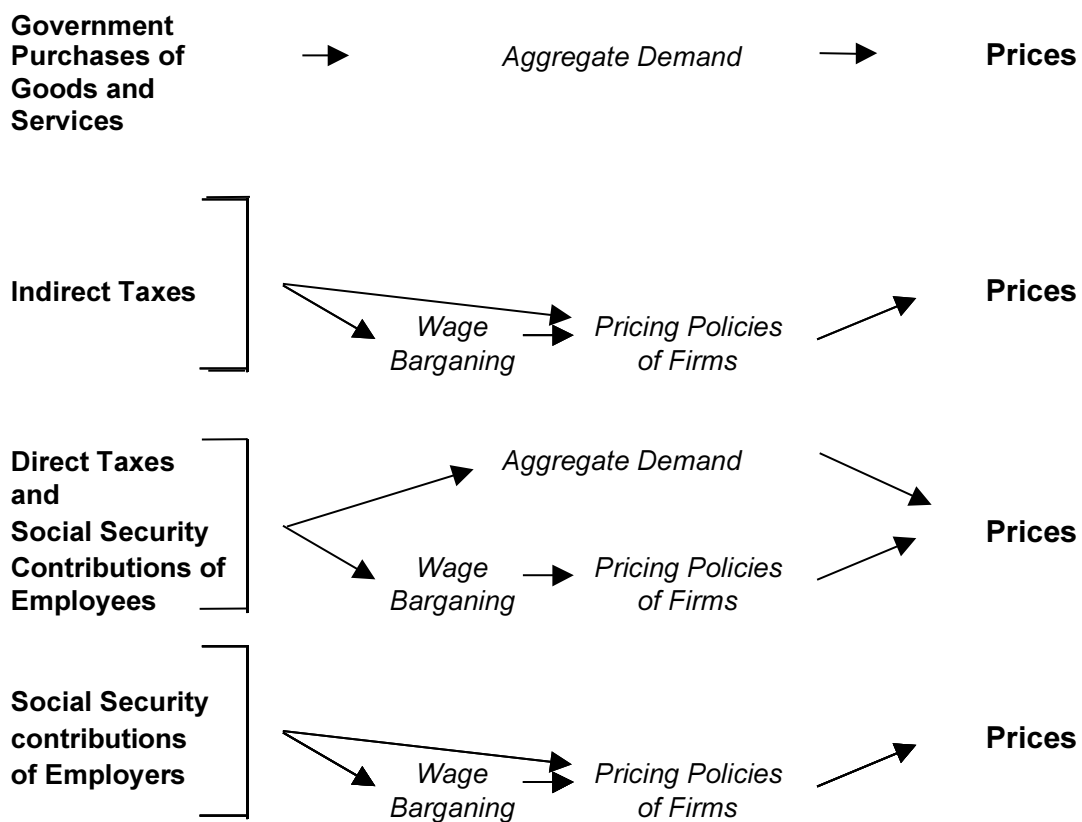
Finally, the GDP (or value added) deflator is the main price measure in all models, *i.e.*, the equation driving the price system. Prices are usually set as a mark-up over marginal costs, which corresponds to unit labour costs. Other determinants include foreign prices and capacity utilisation or the output gap. In addition, in the QUEST model, prices depend explicitly on the frequency of price adjustment, making this behaviour forward-looking.

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[28] Other factors include technological progress (ES and IT models), the stock of capital (AWM, ES) and real wages (AWM, DE, ES, PT).

Chart 1

**AGGREGATE ANALYSES: BUDGET BALANCE**

Budget → *Seignorage* ↘
Balance → *Aggregate Demand* → **Prices**

**DISAGGREGATE ANALYSES: BUDGET COMPONENTS**

**Government Purchases of Goods and Services** → *Aggregate Demand* → **Prices**

**Indirect Taxes** → *Wage Barganing* → *Pricing Policies of Firms* → **Prices**

**Direct Taxes and Social Security Contributions of Employees** → *Aggregate Demand* ↘ → **Prices**
*Wage Barganing* → *Pricing Policies of Firms* ↗

**Social Security contributions of Employers** → *Wage Barganing* → *Pricing Policies of Firms* → **Prices**

Chart 2

**EFFECT OF A 1% GDP INCREASE IN GOVERNMENT PURCHASES OF GOODS AND SERVICES OVER A FIVE-YEAR HORIZON**
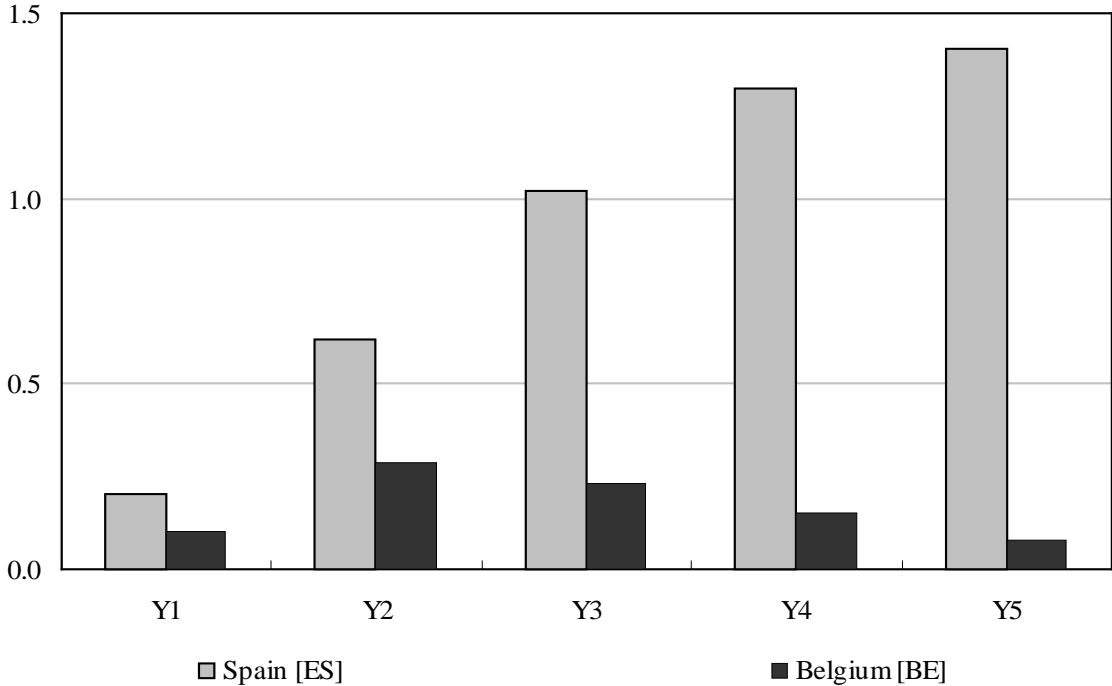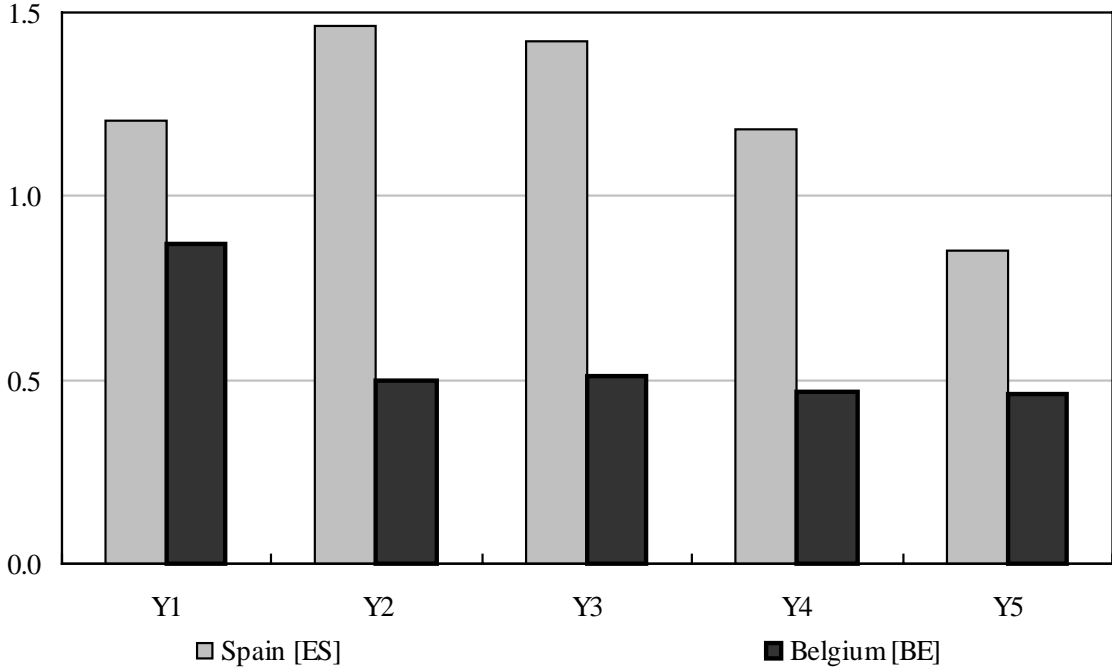
### Chart 2.1 - Private consumption deflator



□ Spain [ES]    ■ Belgium [BE]

### Chart 2.2 - GDP



□ Spain [ES]    ■ Belgium [BE]

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