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Costs and Benefits of Euro Membership: a Counterfactual Analysis

Emmanuel Dubois
Jerôme Hericourt
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Summary

From the very beginning of the nineties until today, the European Monetary Union (EMU) has been a debated idea. Many academics from different fields of international macroeconomics used to predict serious troubles for the central bank which would have to set a common monetary policy for "ill-matched" countries.

Now that monetary integration is effective, this article aims at providing a quantitative assessment of the adequacy (or the inadequacy) of the single monetary policy to each member country. Indeed, while economic analysis generally accepts that agents can know and analyze the potential outcomes of alternative scenarios, empirical works dealing with economic policy practice almost never use the so-called counterfactual approach. One main exception is the contribution of Pesaran *et al*. (2005) who use a global macroeconometric framework (Global Vectorial AutoRegressive, GVAR) to investigate the following question: What if the UK had joined the euro in 1999? The main characteristic of the GVAR framework is that all the considered variables are endogenous, allowing to study interdependencies between all countries.

Our contribution is twofold. First, to our knowledge, it has never been tried to gauge quantitatively the macroeconomic costs or gains of EMU membership. Second, by reversing the problematic of Pesaran *et al*. (2005), we modify the GVAR in order to test different scenarios related to the absence of the euro after January 1999. Echoing a short but intense debate which occurred in Italy in 2005, we also study the potential outcomes if Italy had not participated to EMU Stage 3 in 1999.

This paper sheds light on the following important questions: What if the euro had never been launched? How would have evolved national outputs and inflation rates? What would have been the consequences for Italy of not participating to Stage 3? Based on the comparisons between the "true" GVAR and various counterfactual GVARs, we show that we cannot draw any general conclusion for the three largest euro area members, namely Germany, France and Italy. Indeed, before 1999, France and Germany gain output under the single currency regime in two scenarios, while Italy gains in three scenarios. After 1999, all these countries gain in two scenarios and lose in two scenarios. It is interesting to note that these gains or losses do not occur in the same scenarios for the three countries. It is however certain that these countries had, and probably still have, conflicting interests regarding the most suitable monetary policy for each of them. Conversely, small euro area members like Finland, the Netherlands and Spain, seem to have benefitted from the pre-euro convergence and from the single currency regime. Besides, the single currency regime probably did not have any significant impact on price developments. Finally, the non-participation of Italy to the single currency is quite neutral on the macroeconomic performances of the euro area.

ABSTRACT

The aim of this paper is to gauge quantitatively the macroeconomic costs or gains of EMU membership. Building on the Global VAR framework designed by Pesaran *et al*. (2004), we want to shed light on the following important questions: What if the euro had never been launched? How would have evolved national outputs and inflation rates? What would have been the consequences for Italy of not participating to Stage 3? We show that we cannot draw any general conclusion for the three largest euro area members, namely Germany, France and Italy. It is however certain that these countries had, and probably still have, conflicting interests regarding the most suitable monetary policy for each of them. Conversely, small euro area members like Finland, the Netherlands and Spain, seem to have benefitted from the pre-euro convergence and from the single currency regime. Besides, the single currency regime probably did not have any significant impact on price developments. Finally, the non-participation of Italy to the single currency is quite neutral on the macroeconomic performances of the euro area.

JEL Classification: C32, E17, F42.
Key words: Euro, counterfactual analysis, global VAR.

COÛTS ET BÉNÉFICES DE L'ADHÉSION À L'EURO : UNE APPROCHE CONTREFACTUELLE

RÉSUMÉ

Depuis le début des années 1990, la question de l'Union Monétaire Européenne fait l'objet de nombreux débats. L'intégration monétaire étant effective depuis plusieurs années, l'objet de cet article est de fournir une évaluation quantitative de l'adéquation (ou de l'inadéquation) de la politique monétaire unique pour chacun des douze pays de la zone euro. A cette fin, nous proposons de recourir à une approche contrefactuelle. Il est surprenant de constater qu'une telle approche, qui semble particulièrement adaptée pour appréhender les effets d'une politique économique, a très peu été utilisée dans la littérature. Une exception notable réside dans la contribution de Pesaran *et al.* (2005) qui proposent de retenir un cadre GVAR (Global VAR) afin d'étudier la question suivante : que ce serait-il passé si le Royaume Uni avait rejoint la zone euro en 1999 ? La principale caractéristique de la modélisation GVAR tient au caractère endogène de l'ensemble des variables considérées, permettant ainsi une étude approfondie des interdépendances entre les pays.

Notre contribution se situe à deux principaux niveaux. En premier lieu, il nous semble qu'aucune étude n'existe concernant l'évaluation quantitative des coûts et des bénéfices de l'adhésion à l'Euro. En second lieu, en renversant la problématique de Pesaran *et al.* (2005), nous modifions le cadre GVAR afin de tester divers *scenarii* liés à l'absence de l'Euro après 1999. Afin de donner écho à un important débat qui s'est tenu en Italie en 2005, nous étudions aussi les impacts potentiels de la non participation de l'Italie à la phase 3 de l'UEM en 1999.

Cet article vise donc à répondre aux interrogations suivantes. Quelles auraient les conséquences de l'absence de monnaie unique ? Comment auraient évolué les PIB et les taux d'inflation ? Quelles auraient été les conséquences pour l'Italie de ne pas participer à la phase 3 de l'intégration européenne ? Nos principaux résultats montrent que l'adhésion à la monnaie unique n'a pas eu les mêmes effets pour les trois pays les plus importants de la zone euro, à savoir l'Allemagne, la France et l'Italie. En effet, avant 1999, les effets de l'adhésion à l'euro ont été positifs pour la France et l'Allemagne dans deux *scenarii*, alors qu'ils ont été bénéfiques pour l'Italie dans trois *scenarii*. Après 1999, ces trois pays ont réalisé des gains dans deux *scenarii* et des pertes également dans deux *scenarii*. Il est intéressant de noter que ces gains ou pertes n'apparaissent pas dans les mêmes *scenarii* pour les trois pays. Il est en revanche certain que ces pays ont eu, et ont probablement toujours, des intérêts divergents quant au régime de politique monétaire qui serait le mieux adapté à chacun. Au contraire, les effets de l'adhésion à la monnaie unique semblent positifs pour les "petits" pays de la zone euro, comme la Finlande, les Pays Bas et l'Espagne. Par ailleurs, nos résultats montrent que le régime monétaire unique n'a pas eu d'effet significatif concernant la dynamique des prix et de l'inflation. Enfin, la non participation de l'Italie à la monnaie unique est neutre du point de vue des performances macroéconomiques de la zone euro.

RÉSUMÉ COURT

L'objet de cet article est d'évaluer quantitativement les coûts et les bénéfices de l'adhésion à la monnaie unique pour chacun des douze pays de la zone euro. Nous retenons, à l'instar de Pesaran *et al.* (2005), une modélisation multivariée de type GVAR (Global VAR) afin de répondre aux questions suivantes. Quelles auraient les conséquences de l'absence de monnaie unique ? Comment auraient évolué les PIB et les taux d'inflation ? Quelles auraient été les conséquences pour l'Italie de ne pas participer à la phase 3 de l'intégration européenne ? Nos principaux résultats montrent que l'adhésion à la monnaie unique n'a pas eu les mêmes effets pour les trois pays les plus importants de la zone euro, à savoir l'Allemagne, la France et l'Italie. Il est en revanche certain que ces pays ont eu, et ont probablement toujours, des intérêts divergents quant au régime de politique monétaire qui serait le mieux adapté à chacun. Au contraire, les effets de l'adhésion à la monnaie unique semblent positifs pour les "petits" pays de la zone euro, comme la Finlande, les Pays Bas et l'Espagne. Par ailleurs, nos résultats montrent que le régime monétaire unique n'a pas eu d'effet significatif concernant la dynamique des prix et de l'inflation. Enfin, la non participation de l'Italie à la monnaie unique est neutre du point de vue des performances macroéconomiques de la zone euro.

Classification JEL: C32, E17, F42.
Mots clés: Euro, analyse contrefactuelle, VAR global.

COSTS AND BENEFITS OF EURO MEMBERSHIP : A COUNTERFACTUAL ANALYSIS [1]

Emmanuel DUBOIS[2]
Jérôme HERICOURT[3]
Valérie MIGNON[4]

1 Introduction

From the very beginning of the nineties, the European Monetary Union (EMU) has been a debated idea. Many academics from different fields of international macroeconomics used to predict serious troubles for the central bank which would have to set a common monetary policy for "ill-matched" countries. Using the Optimal Currency Area theories (Mundell, 1961; Mc Kinnon, 1963), Eichengreen (1991) argued that the euro area had neither the labor flexibility and mobility, nor the fiscal integration which are necessary to replace exchange rate adjustments. Moreover, authors like Cukierman and Lippi (2001) stressed that, confronted to the long term trade-off between inflation and employment in case of cyclical shocks, the very inflation-averse European Central Bank (ECB) would be unable to lead any stabilization policy. In other words, the strengthened credibility of the new central banker and the gains related to the reduction of transaction costs would not weigh enough when countries would be confronted to the inability of cushioning asymmetric shocks using the exchange rate.
Now that monetary integration is effective, this article aims at providing a quantitative assessment of the adequacy (or the inadequacy) of the single monetary policy to each member country using a counterfactual approach. Empirical research on macroeconomic policy has rarely used counterfactual analysis. The seminal paper using this approach is Fogel (1964) who studied what would have been the evolution of US economy without railroad. Much more recently, Bordo *et al.* (2006) examined the cost to Switzerland of keeping the hard peg of the franc with gold until 1936, and the potential benefits of following British devaluation in 1931 or the US one in 1933. But the closest experiments to our own research can be found in the recent works by Loisel (2003) and Pesaran *et al.* (2005), who study the symmetric problem regarding the United Kingdom - What if the UK had joined the euro in 1999? Loisel (2003) uses a so-called new-keynesian model based on Clarida, Galí and Gertler (2001). This class of models relies on rational expectations and optimizing behaviors of agents. However, recent research (Mavroeidis, 2005; Canova and Sala, 2006) emphasized the heavy difficulties that plague the estimation of this kind of forward-looking

[1] *Corresponding author*: Valérie Mignon, CEPII, 9 rue Georges Pitard, 75015 Paris, France. Phone: 33 1 53 68 55 62. Email: valerie.mignon@cepii.fr. We would like to thank Agnès Bénassy-Quéré, Olivier Blanchard and Martine Carré-Tallon for helpful comments.
[2] PESOR, University of Paris 11, France. (emmanuel.dubois@u-psud.fr)
[3] EQUIPPE-Universities of Lille and Paris School of Economics, University of Paris 1, France. (jerome.hericourt@univ-lille1.fr).
[4] CEPII, Paris, and EconomiX-CNRS, University of Paris 10, France. (valerie.mignon@cepii.fr).

models, due to identification problems coming from the difficulties to find really appropriate instruments. The reliability of estimated parameters becomes therefore questionable, introducing substantial uncertainties in the forecasting/counterfactual exercise. In that context, the approach of Pesaran *et al.* (2005), based on a fully autoregressive specification, seems safer and more robust. They use a global macroeconometric framework (Global Vectorial AutoRegressive, hereafter GVAR) developed by Dees *et al.* (2005), following Pesaran *et al.* (2004), to investigate the interdependencies between countries belonging to the euro area.

Our contribution is twofold. First, to our knowledge, it has never been tried to gauge quantitatively the macroeconomic costs or gains of EMU membership. Second, we adapt and extend the methodology designed by Pesaran *et al.* (2005) to study the potential impact of UK membership to the euro. By reversing the problematic of Pesaran *et al.* (2005), we modify the GVAR in order to test different scenarios related to the absence of the euro after January 1999. Echoing a short but intense debate which occurred in Italy in 2005, we also study the potential outcomes if Italy had not participated to EMU Stage 3 in 1999.

This paper sheds light on the following important questions: What if the euro had never been launched? How would have evolved national outputs and inflation rates? What would have been the consequences for Italy of not participating to Stage 3? Based on the comparisons between the "true" GVAR and various counterfactual GVARs, our main findings show that we cannot draw any general conclusion for the three largest euro area members. It is however certain that these countries had, and probably still have, conflicting interests regarding the most suitable monetary policy for each of them. Indeed, Conversely, small euro area members like Finland, the Netherlands and Spain, seem to have benefitted from the pre-euro convergence and from the single currency regime. Besides, the single currency regime probably did not have any significant impact on price developments. Finally, the non-participation of Italy to the single currency is quite neutral on the macroeconomic performances of the euro area.

The paper is structured as follows: Section 2 presents the macroeconometric framework. Section 3 addresses methodological concerns and details the different counterfactual scenarios. In Section 4, results of the different scenarios are presented and commented. Section 5 provides concluding remarks.

2 The Global VAR framework

We consider a sample of N countries, $i = 1, ..., N$. In our empirical analysis, $N = 30$,[5] data are monthly and cover the period from April 1980 to May 2006.

The aim of the GVAR framework is to construct a model in which all the variables are endogenous. To this end, we can proceed in three steps.[6]

2.1 Estimation of the individual VAR processes

In a first step, we consider N individual VAR processes, *i.e.* a VAR for each of the N

[5]The considered countries are listed in the appendix.

[6]In this section, we generally follow the presentation of Pesaran *et al.* (2004) and Pesaran *et al.* (2005) to which the reader can refer for more details.

countries:

$$X_{it} = \Phi_{i0} + \Phi_{i1} X_{it-1} + ... + \Phi_{ip} X_{it-p} + \Psi_{i0} X^*_{it} + \Psi_{i1} X^*_{it-1} + ... + \Psi_{ip} X^*_{it-p} + \varepsilon_{it} \quad (1)$$

with $i = 1, ..., N$ is the country and $t = 1, ..., T$ is time. The VAR process contains two types of variables: country-specific and foreign variables. The vector X_{it} is the vector of country-specific variables and X^*_{it} stands for the vector of foreign variables specific to country i. Both vectors contain seven variables, with eventually some restrictions. We have:

$$X_{it} = \begin{pmatrix} LPROR_{it} \\ LCPI_{it} \\ INT_{it} \\ LMONR_{it} \\ LSHAR_{it} \\ LCHUSD_{it} \\ LOIL_{it} \end{pmatrix} \quad (2)$$

where $LPROR$ is the logarithm of the real industrial production, $LCPI$ is the logarithm of the consumer price index, INT designs the short-term nominal interest rate, $LMONR$ is the logarithm of the real money stock, $LSHAR$ stands for the logarithm of real equity prices, $LCHUSD$ is the logarithm of the nominal exchange rate against the US dollar, and $LOIL$ is the logarithm of oil prices.[7] The choice of these variables is standard in the VAR literature on monetary policy (see Sims, 1980 and the surveys by Leeper *et al.*, 1998 and Christiano *et al.*, 1999). Pesaran *et al.* (2004) also retain the same variables. It should be noted that the real money stock is frequently introduced in VAR models, due to the role played by quantitative targeting in the implementation of monetary policy strategies. From a practical viewpoint, this variable allows to distinguish between money supply shocks and money demand ones. We work with monthly data. When necessary, data have been seasonally adjusted.

As previously mentioned, some restrictions have been imposed. This is the case for the oil price and exchange rate variables. For all countries, but the US, oil prices are included as an exogenous variable.[8] By contrast, exchange rates are treated as endogenous for all countries, except for the US $(LCHUSD_{US} = 0)$. The dimension of the vector X_{it} is $(k_i T \times 1)$, k_i being the number of country i-specific variables and T the number of observations. When there is no restriction on the variables, we have $k_i = 7$.

The vector X^*_{it} of foreign variables specific to country i is written as follows:

[7] See the appendix for a detailed description of the data.

[8] To be concrete, this means that $LOIL_{it} = 0$ in the vector X_{it}, except for the US, as in Pesaran *et al.* (2004, 2005). Note that, following the afore mentioned studies, oil prices are expressed in nominal terms.

$$X_{it}^{*}=\begin{pmatrix} LPROR_{it}^{*} \\ LCPI_{it}^{*} \\ INT_{it}^{*} \\ LMONR_{it}^{*} \\ LSHAR_{it}^{*} \\ LCHUSD_{it}^{*} \\ LOIL_{it} \end{pmatrix} \tag{3}$$

where each foreign variable for the country i is calculated as a weighted sum of the corresponding variables of the other countries. In other words, we have:

$$X_{it}^{*}=\sum_{j=1}^{N} w_{ij}X_{jt} \tag{4}$$

where w_{ij} denotes the share of country j in the trade of country i, $i \neq j$. Note that $w_{ii}=0$ and that the sum of the weights is equal to 1, that is $\sum_j w_{ij}=1$. The weights rely on the geographic distribution of imports and exports of goods and services in 2004 and are taken from the CEPII-BACI database.[9] It should be noted that the US model presents specificities reflecting the impact of the US economy on some worldwide variables like oil prices. In other words, some restrictions are imposed concerning the US variables: only $LPROR^{*}$ and $LCPI^{*}$ are considered as exogenous in the US model. The dimension of the vector X_{it}^{*} is $(k_i^{*}T \times 1)$, k_i^{*} being the number of foreign variables for country i. As for k_i, $k_i^{*}=7$ when no restriction is imposed on the variables.

This first step consists in the estimation of (1) on a country-by-country basis. For checking time series persistence, we used ADF (Augmented Dickey-Fuller), PP (Phillips-Perron) and KPSS (Kwiatkowski, Phillips, Schmidt and Shin) tests. It appeared that the series were almost all integrated of order one. Small sample bias of the standard Johansen cointegration tests are well-known, so we decided to estimate the different VARs in levels. As shown by Sims *et al.* (1990), this still yields consistent estimates.[10]

Regarding the lag-order of the individual VARs, we privileged the recommendations of the likelihood ratio tests by choosing a number of lags $p=6$.[11] The use of monthly data gives us more degrees of freedom, allowing therefore to choose a lag-order conforming more with conventional wisdom concerning monetary policy transmission. This gives us a non-negligible empirical advantage compared to previous studies by Pesaran *et al.* (2004, 2005).

[9] Note that we use the 2004 trade matrix, *i.e.* constant weights over our considered period. It should be noted that retaining fixed or variable trade weights had a negligible impact on the results.

[10] This estimation strategy in presence of integrated series is more and more widely used in the VAR literature. See in particular Kim and Roubini (2000), Elbourne and de Haan (2006) and Hericourt (2006).

[11] The standard information criteria (Schwarz, Hannan-Quinn, Akaike) tended to recommend a very low lag-order, around one or two. DeSerres and Guay (1995) show that these criteria tend to underperform compared to the likelihood ratio test. Besides, a too short lag structure can lead to a significant estimation bias. Since we want to stick as closely as possible to the data generating process, this is a risk we do not want to run.

2.2 Stacking the variables

At the end of the previous stage, 30 individual VAR processes have been estimated. As previously mentioned, the aim of the GVAR framework is to derive a model in which all the variables are endogenous. To this end, the methodology first consists in stacking the country-specific and foreign variables. In other words, we combine the individual VAR processes to study the dynamics for all the variables and all the considered countries simultaneously.
Equation (1) can be written as follows:

$$\Gamma_{i0} Z_{it} = \Phi_{i0} + \Gamma_{i1} Z_{it-1} + ... + \Gamma_{ip} Z_{it-p} + \varepsilon_{it} \tag{5}$$

with:

$$Z_{it} = \begin{pmatrix} X_{it} \\ X_{it}^{*} \end{pmatrix} \tag{6}$$

and:

$$\Gamma_{i0} = \begin{pmatrix} I_{k_i} & -\Psi_{i0} \end{pmatrix}, \Gamma_{i1} = \begin{pmatrix} \Phi_{i1} & \Psi_{i1} \end{pmatrix}, ..., \Gamma_{ip} = \begin{pmatrix} \Phi_{ip} & \Psi_{ip} \end{pmatrix} \tag{7}$$

Note that the dimensions of these matrix are $(k_i \times (k_i + k_i^{*}))$.
Let us denote W_i the trade matrix for country $i, i = 1, ..., N$. In other words, W_i includes the trade weights w_{ij} used to define the foreign variables (see Equation (4)). Moreover, we define X_t as the vector which put together all the endogenous variables of the system, that is:

$$X_t = \begin{pmatrix} X_{1t} \\ X_{2t} \\ \vdots \\ X_{Nt} \end{pmatrix} \tag{8}$$

Given these definitions, we can write:

$$Z_{it} = W_i X_t \tag{9}$$

2.3 Expression of the GVAR

Replacing the Z_{it} variables in (5) by their expressions given in (9) leads to:

$$\Gamma_{i0} W_i X_t = \Phi_{i0} + \Gamma_{i1} W_i X_{t-1} + ... + \Gamma_{ip} W_i X_{t-p} + \varepsilon_{it} \tag{10}$$

which can be written as:

$$\Omega_0 X_t = \Phi_0 + \Omega_1 X_{t-1} + ... + \Omega_p X_{t-p} + \varepsilon_t \tag{11}$$

with:

$$\Omega_j = \begin{pmatrix} \Gamma_{1j} W_1 \\ \Gamma_{2j} W_2 \\ \\ \Gamma_{Nj} W_N \end{pmatrix} \text{ for } j = 1, ..., p \tag{12}$$

and $\Omega_0 = \Gamma_{i0} W_i$, $i = 1, ..., N$. ε_t is given by:

$$\varepsilon_t = \begin{pmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \vdots \\ \varepsilon_{Nt} \end{pmatrix} \tag{13}$$

Finally, the GVAR can be expressed as:

$$X_t = G_0 + G_1 X_{t-1} + ... + G_p X_{t-p} + u_t \tag{14}$$

with: $G_0 = \Omega_0^{-1} \Phi_0$, $G_j = \Omega_0^{-1} \Omega_j$, $j = 1, ..., p$, and $u_t = \Omega_0^{-1} \varepsilon_t$.
This last equation defines the GVAR process in which all the variables are endogenous.

3 Counterfactual scenarios: Methodological options

Our purpose is to simulate different scenarios of non-participation to the euro. Formally, this will be done by (i) estimating the GVAR on a sub-period preceding the European Exchange Rate Mechanism (ERM) crisis and (ii) imposing restrictions to the interest and exchange rate equations of the GVAR. Afterwards, the difference between the forecast produced by the unrestricted GVAR and this restricted forecast will be analyzed. Following Pesaran *et al.* (2005), we do not compare the outcomes produced by the alternative scenario to the actual data. If we consider the latter as restricted forecasts, it may be difficult to perform clear comparisons, since it will not be possible to distinguish between the effects of forecasts errors and the effects of the restrictions imposed. Here, we avoid the problem by studying the difference between the unrestricted and restricted forecasts.
By comparing directly the unrestricted and restricted forecasts after the date when the restriction is introduced, we also implicitly consider that there was no structural change of all equations but the interest and exchange rates ones. Indeed, if a structural breakdown occurred around the considered date, we would not be able to determine whether the differences stated between the two forecasts come from monetary transmission changes induced by the pre-euro nominal convergence or only from the switch of several monetary policies to a single one. Of course, this assumption can be challenged by the Lucas critique. On the theoretical ground however, Pesaran *et al.* (2005) emphasize that Dynamic Stochastic General Equilibrium Models (DSGE)[12] have VARs with restrictions on the coefficients as reduced

[12]These models incorporate rational expectations and are therefore robust to the Lucas critique.

forms. The Lucas critique can also be empirically addressed by structural breakdown tests (cf. Rudebusch and Svensson, 1999). Indeed, if these tests do not detect any structural break around the considered date, then the Lucas critique does not hold on the empirical ground. Consequently, standard breakpoint Chow (1960) tests and recursive least squares tests are performed for all equations, except interest and exchange rate ones.[13] The test statistics are significant and emphasize the overall stability of all equations over the 1980:04-2006:05 period. Consequently, we conclude that the Lucas critique is not historically validated in our case. On the theoretical ground, the hypothesis supporting the different scenarios we implement, through imposing restrictions on parameters, allows to model directly in the GVAR the structural changes implied by the different alternatives. Doing so, we believe we also address conceptually the critique. Note that this clearly raises crucial identification issues. Ideally, we should make hypotheses on the equations of the structural model in order to support restrictions on the reduced-form equations. But, this would imply to have a global structural model (possibly a DSGE model) and the building of such a model is clearly beyond the scope of our paper. To circumvent this point, we draw on the structural VAR (SVAR) literature *à la* Kim and Roubini (2000) and Elbourne and de Haan (2006). The main idea of this literature is to identify structural shocks by imposing restrictions on the contemporaneous correlation matrix linked to reduced form shocks. Based on a macroeconomic model with optimizing agents developed by Sims and Zha (1998), the structural factorization designed by Kim and Roubini (2000) for small G7 economies seems to be a good starting point to develop intuitions on reduced-form equation parameters. Following this idea, the scenarios we are going to implement are based on restrictions on exchange and/or interest rate equations accounting for different degrees of sensitivity to supply shocks, external constraint and monetary policy autonomy.

Turning to the scenarios themselves, they aim at providing answers to two crucial questions: can we outline differences between the single currency world and various counterfactual ones where countries keep their own currencies? And more generally, would European countries have benefitted from less conservative monetary policies, as argued by many academics in the nineties (see in particular De Grauwe, 1995)? To answer these questions, we consider five different counterfactuals. The two first ones are two polar cases with the same basis. They both postulate that the European Exchange Rate Mechanism does not survive to the September 1992 crisis, and that all euro area (EA) members come back to floating exchange rates. Therefore, we reestimate[14] the GVAR over the 1980:04-1992:09 period and proceed as follows. In the first scenario, all EA members decide to use the German monetary rule. This is modelled by imposing German coefficients for interest and exchange rates behaviors, that is, by constraining coefficients of all EA members interest and exchange-rate equations to be equal to the German ones. In the second scenario, EA countries decide to follow the British monetary rule, the UK being a genuine floater. We proceed the same way we did for the German case, by constraining coefficients of all EA members interest and exchange-rate equations to be equal to the British ones. This scenario may appear as a textbook experiment. However, it constitutes a relevant benchmark since many observers and academics

[13] More details of these tests available from the authors on request.

[14] We reestimate each individual VAR.

considered that UK monetary policy was much more suitable regarding both output growth and stabilization than the European / German-lead ones (see, among others Coquet and Le Bihan, 1997).

The third scenario we set up draws on the same idea that after the ERM crisis of September 1992, all ERM members eventually chose to go back to floating exchange rates. But this is modelled now by imposing on all GVAR equations the parameters estimated over the 1980.04-1990.10 time span.[15] This is done to prevent parameters from being influenced by the "hard EMS" experience, giving therefore a more realistic picture of a floating rates universe for ERM members. We also presume that, freed from the pegging constraint, all countries but Germany would adopt an expansionary monetary policy with a 400 basis points cut of interest rate and a depreciation of 15 % of exchange rates.[16]

The fourth counterfactual takes a further step by examining the consequences of an 'optimal' monetary policy for the euro area members. More precisely, we still presume that after September 1992, former EMS members went back to floating exchange rates, but monetary authorities decided to adopt a Taylor (1993)-type monetary policy. As emphasized by Judd and Rudebusch (1998) and Svensson (2003), a good monetary policy is one that deals successfully with the trade-off between the short-run goal for stabilizing the output around potential output and the long-run goal for inflation. In its seminal paper of 1993, Taylor proposed a simple equation to put forward this dilemma:

$$r_t = \lambda + \gamma\left(\pi_t - \pi^*\right) + \rho\left(y_t - y^*\right) \tag{15}$$

where r_t is the short-term interest rate, $\left(\pi_t - \pi^*\right)$ is the difference between current inflation and the targeted level desired by the central bank, $\left(y_t - y^*\right)$ stands for the output gap, and λ is a constant, equal to the sum of the equilibrium short term interest rate and the inflation target.

To have an idea of the interest rates prescribed by the Taylor rule since 1999, we compare them with the actual rate set by the ECB. For an illustrative purpose, we focus on French and German cases. To compute these Taylor rates, we follow Sack and Wieland (2000) by introducing a smoothing term[17] in the rule. We set the real equilibrium interest rate at 2.5% (a figure consistent with the estimates of potential growth for these two countries over the period) and the inflation target at 2% (consistent with the official or non-official targets of both Banque de France and Bundesbank). Turning to the coefficients on gaps, we take a value of 1.5 on the inflation gap and 0.5 on the output gap as in Taylor (1993). Figure 1 depicts the evolution of Taylor rates for France and Germany, and the actual 3-months interest rate in the eurozone over the 1999:01-2006:05 time span.

It is striking to see that until 2001, both Taylor rates are very close to the actual euro one. Conversely, both computed rates are definitely far above the euro rate after 2001, and the gap

[15] Actually this period includes the span of the "golden ERM" (1987-1990). We did another set of simulations over the 1980-1987 period, leading to similar results.

[16] The size of the interest rate cut and the percentage of depreciation correspond roughly to the variations observed for British interest and exchange rates when leaving the ERM.

[17] An "ubiquitous feature of central bank behavior" for Faust et al. (2001), smoothing interest rate changes helps to maintain a stable environment for bond and equity markets, which could be disrupted by sudden variations of the interest rate.

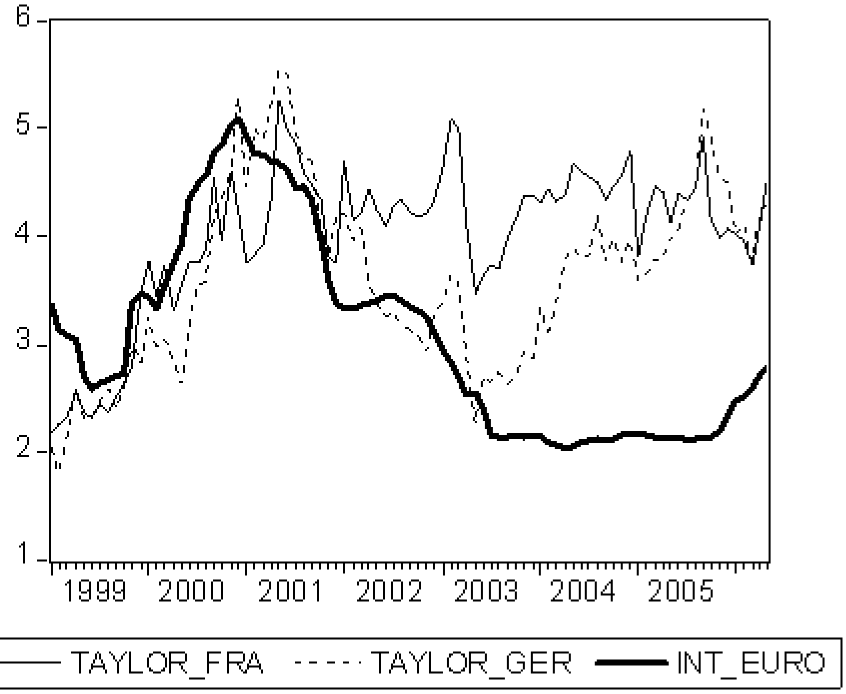

Figure 1: Evolution of German and French Taylor interest rates and euro interest rate.

seems to increase over time. In other words, the monetary policy bias of the ECB has been an expansionary one according to the Taylor rule criterion.

To implement the fourth counterfactual, we reestimate the GVAR over the 1980.04-1992.09 period, and we directly impose restrictions on the interest rate equations by modifying the parameters on prices, output and exchange rates. Formally, we impose a 0.5 coefficient on the first lag of output, 1.5 on the first lag of prices[18] and 0 to all other lags of output and prices, and to all exchange rate lags. All other parameters of the interest rate equations are left unchanged.[19] It is worth noting that Germany is not concerned by these modifications, all parameters of German remaining unchanged. Indeed, over all the considered period, Germany was the only country to have an autonomous monetary policy since it was the EMS leading country.

Echoing a short but intense debate which arose in Italy in June 2005, the last counterfactual we propose aims to figure out the consequences for this country of non-membership to euro. Formally, we imagine that Italy renounced, or was unable, to join the single currency at the very beginning of 1997, so that the lira would have never joined the EMU.[20] Formally, we reestimate only the Italian VAR over the 1980:04-1997:01 period, leaving all the other coefficients of the GVAR unchanged.

4 Results

We start by solving the original GVAR, in order to have an overview of its ability for reproducing the real data. The real data and the corresponding unrestricted forecasted ones are graphically reported on Figures 0a to 0c.[21]

These graphs show that the GVAR reproduces fairly well the original data. Differences between the real data and the forecasted ones are insignificant, and the different trends and evolutions are perfectly reproduced. In the context of our counterfactual exercise comparing

[18]As previously mentioned, these coefficients are the ones proposed by Taylor in his paper. Some would argue, however, that the actual Taylor rule relies on contemporaneous values of output and inflation, and even, that forward-looking rules would be more relevant. McCallum (1999) provides a discussion on the unobservability of current output and prices for a monetary policy rule.

[19]It should be noted that the constant term of the interest rate equations has not been calibrated. Indeed, it has been estimated since the values of the neutral interest rate are quite different across countries (see Clarida et al., 1998, 1999; Héricourt, 2005). Moreover, the constant term does not strictly represent the neutral rate since interest rate equations also contain other variables than national output and prices. Another justification lies in the fact that if coefficients on output and prices can be related to the preferences of policy-makers, the neutral interest rate is more representative of the structural nature of the economies.

[20]The Italian currency joined the ERM on November 24, 1996, after more than four years of floating rates following the ERM crisis of September 1992. By setting a counterfactual where the lira stays out of the ERM without any hope of participation to the single currency, we remove the benefits of pre-euro convergence from the data, making the assumption attractive to our eyes.

[21]To save space, we report the dynamics of only three variables (interest rates, industrial production and consumer price index) for the EA members. Graphs relating to the other variables and countries are available upon request to the authors.

the unrestricted forecasts with restricted ones, we can therefore consider that the GVAR is a quite good representation of the data generating process. We now turn to the analysis of each scenario.

4.1 Scenario 1: German monetary rule

The first scenario examines a counterfactual without euro, but where all EA members decide to follow the German monetary rule. This is modelled by imposing German parameters in all interest and exchange-rate equations for EA countries.[22]

Figure 1a[23] shows the effects of the absence of single currency (the point estimate with single currency less the point estimate without single currency) on interest rates for all EA countries. The different graphs clearly indicate that interest rates tend to be substantially higher in the world without euro than in the world with euro. Indeed, the gap is substantially negative for all countries[24], and it tends to increase in absolute value across the years. It is also interesting to notice that the countries which have been the most concerned with monetary instability during the 1980s are also the ones suffering the highest interest rates in the counterfactual world, that is Ireland, Italy, Greece, Portugal and Spain. They all exhibit substantial risk premia with the German interest rate.

To a lesser extent, we find similar profiles for Austria, Belgium, Finland, France, Luxembourg and Netherlands. The positive gap with German interest rates exists, but is much lower than for the previous group of countries. This hierarchy between countries is a first indication that our counterfactual is correctly designed, since it extrapolates plausibly what actually happened in the old EMS before 1992-1993.[25]

Figures 1b and 1c present the effects of the absence of euro on output and prices for all EA countries. Regarding output, two groups of countries emerge. The first one shows a clear and increasing trend (at least until 2000) for higher output in the world with the single currency. It is made of Austria, Finland, Greece, Ireland, Luxembourg, Netherlands and Spain. Conversely, France, Italy, Portugal, and to a lesser extent Belgium and Germany, form a second group where output is smaller with the single currency than without. It is particularly striking that the three major EA countries (France, Germany, Italy) are losing output

[22] As previously mentioned, from a practical viewpoint, we reestimate the individual VAR models on the 1980:04-1992:09 period. The estimated coefficients are then put in the GVAR corresponding matrix. The GVAR model is then simulated until the end of the period, the residuals being automatically recalculated in the GVAR.

[23] Detailed tables of results available upon request to the authors.

[24] For instance, the gap in percentage points is around 10-12 for France, Luxembourg, Portugal and Spain and achieves substantial values for Ireland and Italy (17-19 in percentage points) at the end of the period. Of course, we do not claim that these values represent exactly what would have happened under Scenario 1. As we already mentioned, errors are unavoidable in the context of the forecast exercise. But the trend is unequivocal, interest rates would have definitively been higher under a German monetary rule in these countries.

[25] In the remainder of the paper, we won't display interest rates figures in order to save space, our primary focus being on output and prices development. They of course remain available upon request. The example of scenario 1 emphasizes that the GVAR model is sufficiently well-designed to perform plausible evolutions of interest rates under alternative policy regimes.

compared to the counterfactual universe without single currency, despite lower interest rates. However, while France and Italy exhibit a quite clear negative trend, the German evolution remains specific. The negative trend is definitely present until 2000, then the gap tends to reduce for a year or so, then increase again until 2002. A radical shift occurs afterwards: the negative gap shrinks, then turns positive in April 2004. Overall, these graphs show that the road to euro possibly generated losses of output for the three countries representing 80 % of EA GDP. The magnitude of these losses is not equal across countries however: Italy's (like Portugal) losses are much more consequent (between 3 to 4 times) than the German or French ones. This is quite normal, if we think that Italy needed much more efforts to reach the nominal convergence criteria imposed by the Maastricht Treaty. Besides, while Germany seems to adapt to the single currency regime with a gap turning positive at the end of the period (April 2004), France and Italy keep having a lower output in the single currency world. This might be related to the difficulties of the single monetary policymaker to fit the various macroeconomic situations within the euro area.

Concerning prices, the order of magnitude for differences is much lower. This is also unsurprising, if we think that in the counterfactual, the leading German monetary policy would be directed toward price stability, like the one of the ECB. It is still possible to emphasize a couple of interesting differences, however. Two groups of countries emerge. For the first one (Austria, Finland, France and Greece), prices are lower in the world with euro than in the counterfactual without single currency. Except for Austria, where it tends to shrink after 2000, the gap is on an increasing trend for the other three concerned countries. For all other EA countries, prices seem to be higher in the specification with the single currency, but the impact is actually negligible for Germany, Luxembourg, Netherlands, Ireland and Spain. For the remaining one, the positive gap seems to be on an increasing path until 2000-2001, after which it is reducing or stabilizing. In any case, the impact on prices of the single currency compared to the counterfactual without euro never exceeds 0.35-0.4%.

4.2 Scenario 2: British monetary rule

In this second counterfactual, we imagine that, after the ERM crisis of September 1992, countries would have followed the same kind of monetary policy than the British one, with strong interest rates cuts. This is modelled by imposing British parameters in all interest and exchange-rate equations for EA countries.

Figures 2a and 2b present the effects of the absence of euro on output and prices for all EA countries. For most countries, output is higher with the single currency than without. The magnitude of these gains is heterogenous, however: quite small for Belgium or Finland, they are more important for Italy, Netherlands and Portugal. The output gains reach even more consequent levels for France, Luxembourg, Ireland and Spain. Conversely, the output gaps between the world with euro and the world without are negligible in average for Austria and Greece. Interestingly, the only country which clearly and really gains output under the British monetary rule is Germany. That means that Germany loses output under the single currency regime. These losses are very important, and the trend of the gap is quite regular. According to scenario 2, a more counter-cyclical monetary policy would have helped the German economy to go through the first post-reunification years.

Turning to price concerns, the magnitude of the gaps is once again much lower in average than for output. For Germany and its three monetary satellites (Austria, Belgium, Netherlands), prices are slightly lower with the single currency than without. This is also the case for Ireland and Spain. For the latter, the gap tends to shrink after 1998, getting close to zero at the beginning of 2006. For all others, prices tend to be higher with the single currency, but the impact is actually negligible for most of them. The small size of these differences can easily be explained by the features of UK monetary policy, which was also directed toward price stability. In other words, even if EA countries had given up the idea of monetary unification, they could not have afforded to give up price stability.

4.3 Scenario 3: Pre-1990 monetary rules

The third scenario builds on the hypothesis that following the "hard EMS" period, all ERM members eventually chose to go back to floating exchange rates. As shown by Clarida *et al.* (1998), the period between 1990 and September 1992 is characterized by a strong commitment of all member countries to a hard peg with the Deutsche Mark without any devaluation, whatever the cost. These two years saw a sharp rise of nominal interest rates in a context of strong economic slowdown. The heavy difficulties of European countries, especially, UK and Italy, eventually led to the exchange rate crisis of September 1992, the British Pound and Italian Lira leaving definitely the ERM. In this third counterfactual, we imagine that all ERM countries decided to let their currencies freely float. This is modelled by imposing on all GVAR equations the parameters estimated over the 1980.04-1990.10 span. This is done to prevent parameters from being influenced by the "hard EMS" experience, giving therefore a more realistic picture of a floating rates universe for ERM members. Besides, we presume that, freed from the pegging constraint, all countries but Germany would adopt an expansionary monetary policy with a 400 basis points cut of interest rate and a depreciation of 15 % of exchange rates.

Figure 3a (resp. 3b) shows the difference between the evolution of industrial production (resp. CPI) from the GVAR with single currency and the same dynamics obtained from the counterfactual with fully floating exchange rates. Regarding output, countries split into two groups: for Austria, Belgium, Finland, Germany, Greece, and the Netherlands, production tends to be systematically higher in the world with the single currency, most of the time with an increasing trend. At the end of the studied period, these gaps can reach substantial amounts until 1.2 - 1.4% for some countries. The second group, made of France, Ireland, Italy, Luxembourg, Portugal and Spain, conversely exhibits negative gaps between the world with the single currency and the world without, which tend to increase in absolute value. If the output losses are quite negligible for France, they reach very significant amounts for Italy, Spain, Portugal and especially Ireland. These results emphasize that these five countries would have benefited more or less from a more expansionary monetary policy. This confirms the idea that, among the big countries, France and especially Italy, paid some kind of output price on the past of the euro. This is also the case for Spain and Portugal which had to maintain high nominal interest rates until the very end of the nineties to prevent too important depreciation of their currencies.

Turning to prices (Figure 3b), the differences between the GVAR with euro and the counterfactual without are once again very small. They are very close to zero for Germany, Greece, Ireland, Luxembourg, the Netherlands and Spain. Austrian prices tend to be slightly higher in the counterfactual with the single currency, while Finland, France, Italy and Portugal exhibit a negative gap with a decreasing trend in absolute value. For these four countries, this emphasizes that the path to single currency had somewhat contributed to price stability, but not in a decisive fashion.

4.4 Scenario 4: Taylor rules

The fourth scenario we consider builds on the same idea than the previous one, but addresses it quite differently. We now suppose that after the ERM crisis of September 1992, ERM members decided to follow a Taylor (1993) type monetary policy. Therefore we reestimate the GVAR over the 1980.04-1992.09 period, but we directly impose restrictions on the interest rate equations of all euro area members but Germany, by modifying the parameters on prices, output and exchange rates. Formally, we impose a 0.5 coefficient on the first lag of output, 1.5 on the first lag of prices and 0 to all exchange rate lags.[26] All the other parameters of the interest rate equations are left unchanged.

Figure 4a shows the difference between the evolution of industrial production from the GVAR with single currency and the GVAR with floating exchange rates and Taylor rules. Once again, the twelve euro area members divide in two equal groups. Made of Austria, Belgium, Germany, Greece, Ireland and Luxembourg, the first group exhibits negative gaps, that is losses of output in the world with euro compared to the one without. The magnitude of these losses in absolute value ranks in average from 0.15% (Belgium) to 2% (Ireland). The trends of the gaps are not identical among countries, however. For Austria, Belgium and Ireland, the situation is quite neutral over the 1993-1999 period, and for Luxembourg, an average gain of 0.4% can even be detected. After 1999, the output in these four countries starts to be higher in the counterfactual world without euro, with an increasing trend. The losses are especially severe in Ireland, between 2 and 3% after 1999. For Germany and Greece, the losses are systematic, and increase since the beginning of the period (or almost). These results show that Germany possibly suffered from an over-restrictive monetary policy (as depicted by the GVAR with euro), and that the five others, all very little opened economies, lost output in order to maintain the nominal anchorage of their currency with the Deutsche Mark and/or to fulfill convergence criteria. Some would argue, however, that output in Ireland actually grew very fast in the nineties, and that the additional two percentage points of the scenario based on a Taylor rule would seem more like overheating. From that point of view, convergence efforts on the way to euro were useful to Ireland.

Made of Finland, France, Italy, Netherlands, Portugal and Spain, the second group exhibits a higher output in the GVAR with euro. The average magnitude of the gaps ranks from 0.2% (France) to 3% (Portugal). Gaps are especially low for the two big countries, France and Italy, but with opposing trends. According to these results, the effects of both monetary regimes on output are quite similar. These results may appear puzzling, because interest rates in the single currency regime are lower than under the Taylor-rule regime. In that

[26] For robustness checks, we have considered various values for the first lagged coefficient of prices. The results were identical.

context, one would expect a higher growth in the world with euro. Actually, the answer comes from the exchange rates. According to our calculations, the USD / FF exchange rate would have depreciated by 35% under the Taylor-rule regime, versus 8% in the real world.[27] This simply means that in the counterfactual universe without euro, higher interest rates are offset by a depreciation of the exchange rate. Conversely, output gains are substantial for small countries like Finland, Netherlands, Portugal and Spain. We can easily imagine that these countries benefited from lower nominal interest rates in the context of pre-euro convergence, that wouldn't have occurred in the context of autonomous monetary policy.

As already seen in the previous counterfactuals, the price gaps (shown on Figure 4b) are much lower in magnitude than for output. They are very close to zero for Finland, France and Luxembourg. For Austria, Belgium, Germany, Greece, Ireland, and Netherlands, there seems to be slightly more inflation in the GVAR with euro, with positive gaps ranking from 0.1 to 0.2% in average. Conversely, inflation is lower in the GVAR with euro in Spain (-0.1%) and in Portugal (-0.3%). Once again, the transition to single currency does not seem to have influenced decisively price evolutions when comparing with a free floating/autonomous monetary policy regime.

4.5 Scenario 5: Non participation of Italy

The last scenario we consider wants to figure out the consequences for Italy of not participating to the single currency. More precisely, we imagine that Italy renounced to euro membership at the end of 1996, just before the date when Italian Lira actually came back in the ERM. In other words, we suppose in the counterfactual that Italy had the same path until January 1997, but eventually decided not to join the ERM. This is modelled by reestimating the Italian VAR over the 1980:04-1997:01 period, leaving all the other parameters of the GVAR unchanged. Therefore, we presume that Italy maintained the monetary framework of the mid-1990s, with a strong commitment toward price stability and a floating exchange rate.

Figures 5a and 5b present the effects of the absence of euro on output and prices for all EA countries. These graphs show that the difference between the world with euro and the world without single currency is clearly negligible. In other terms, if EA had been deprived from Italy participation, output and prices in members countries would have not been different of what they are in the world with euro. More surprisingly, it is also the case for Italy. This emphasizes that even without the single currency, Italy would have kept its macroeconomic policies in line with the ones of the euro area.

4.6 General assessment

Tables 1 and 2 summarize the results of the five studied scenarios, in terms of, respectively, output and prices. The results are expressed as gaps between the outcomes of the GVAR with the single currency and the counterfactual without. Therefore, "higher" means that output or prices in the world with euro is higher than in alternative scenario. The gap is considered

[27] Similar figures were found for Italy.

as negligible if it fails to reach 0.1% at least once during the period of the studied scenario. Figures 6a and 6b also synthesize the results obtained for the first four scenarios.
Table 1 outlines several important results. First, some euro area countries exhibit output gains compared to at least three scenarios: Finland (4), Netherlands (4), and Spain (3).[28] This is a group of small open economies, for whom the benefits of the single currency have possibly exceeded the costs. This outcome could notably be attributed to the credibility gains for monetary policy (translated into lower interest rates). Conversely, the results are less clear-cut for the largest countries forming 80% of euro area's GDP, namely Germany, France and Italy. For these countries it might be interesting to distinguish before and after the introduction of the euro. Before 1999, France and Germany gain output under the single currency regime in two scenarios, while Italy gains in three scenarios. After 1999, all these countries gain in two scenarios and lose in two scenarios. It is interesting to note that these gains or losses do not occur in the same scenarios for the three countries. France and Italy tend to loose output in scenarios 1 and 3, whereas Germany tends to gain output in these scenarios. Conversely, France and Italy make gains in the single currency world relatively to the UK and Taylor's monetary rules, whereas German situation gets better under these monetary regimes compared to the real world. Emphasizing the conflicting interests of the three largest EA members, these results support that a single monetary regime could not fit the various situations of these countries at least until the end of 2005.
Table 2 emphasizes that differences in terms of prices between the GVAR with euro and the different scenarios are mostly negligible. This clearly shows that, whatever the alternative exchange rate regime and monetary policy framework, euro area members could not have afforded to give up price stability. For some countries however, there is a slightly significant impact of monetary union on prices: Finland and Greece probably had lower prices in the euro area context, while Portugal probably had higher prices. With smaller output and higher prices, Portugal is consequently the only country for which the pre-euro convergence and the monetary unification have brought only costs.

5 Conclusion

The purpose of this paper consisted in providing quantitative estimations of gains and costs of monetary integration for the euro area countries. To do so, we used a GVAR model in order to test different scenarios related to the absence of single currency, and echoing a recent debate in Italy, we also studied a situation in which this country would have not participated to the single currency.
We cannot draw any general conclusion for the three largest EA members. It is however certain that these countries had, and probably still have, conflicting interests regarding the most suitable monetary policy for each of them. None of our alternative scenarios could find a situation where the three countries would have gained output at the same time. Conversely, small euro area members like Finland, the Netherlands and Spain, seem to have benefitted from the pre-euro convergence and from the single currency regime. Besides, the single

[28] Between parentheses: the number of scenarios where the considered country displays output gains in the GVAR with euro.

currency regime probably did not have any significant impact on price developments. Finally, the non-participation of Italy to the single currency is quite neutral on the macroeconomic performances of the euro area.

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Appendix

We consider a sample of 30 countries. They are listed in the following table.

Argentina	Germany	Norway
Australia	Greece	New Zealand
Austria	India	Portugal
Belgium	Ireland	South Africa
Brazil	Italy	Spain
Canada	Japan	Sweden
China	Korea	Switzerland
Denmark	Luxembourg	Turkey
Finland	Mexico	United Kingdom
France	Netherlands	United States

Data are taken from various sources:

- Bilateral exchange rates against the USD are taken from IFS (International Financial Statistics, IMF), with the exception of the Greek series which is extract from Datastream. Note that exchange rate series are expressed in nominal terms and are considered in logarithms.

- Consumer price indexes (CPI) are generally taken from IFS, except for Australia and New Zealand (Datastream). China is also an exception since CPI data are issued from WDI (World Development Indicators, World Bank). All CPI series are based in 2000.01 such that 2000.01 = 100. They are expressed in logarithms.

- Industrial production series generally come from IFS. Note that, for 7 countries — Argentina, Australia, Brazil, China, Greece, New Zealand and Switzerland — the series are taken from Datastream. Industrial production series are expressed in real terms, *i.e.* they have been deflated by the corresponding CPIs. All industrial production series are based in 2000.01 (i.e. 2000.01 = 100) and are transformed into logarithms.

- Concerning money, we generally consider the M1 aggregate, with the exception of Brazil, Germany and Sweden for which we use the M3 aggregate. Money series are taken from Datastream for China, France, Ireland, Italy, Luxembourg, Mexico, the Netherlands and Greece. For some series, two sources are used: Austria (Datastream and Osterreichische National Bank), Belgium (Datastream and Eurostat), Denmark (Datastream and IFS), Germany (IFS and Deutsche National Bank), Norway (Datastream and IFS), Portugal (Eurostat and Banco de Portugal), and Spain (Datastream and Eurostat). For the other countries, series are extracted from IFS. Money series are expressed in logarithmic real terms (deflated by corresponding CPIs) and converted in USD.

- Interest rate series are generally taken from IFS. For three countries, Denmark, Luxembourg and Portugal, data are issued from Eurostat. For India and New Zealand, the data are given by the Reserve Bank, and by the Central Bank for Norway. The considered series are short term nominal interest rates (call money rate, one month or three month rates, depending upon the considered country and data availability).

- Concerning share prices, series are mainly taken from IFS. We use data from Datastream for Denmark, France, Sweden. For Austria, Luxembourg, Norway and Portugal, data are taken from IFS and Eurostat. Finally, for UK, we use Eurostat database. All series are expressed in real terms (*i.e.* deflated by corresponding CPIs) and in logarithmic terms. They are based in 2000.01 such that 2000.01 = 100.

Finally, due to data availability or to the presence of outliers, some series are not considered in our sample. This is the case for interest rate series for Argentina, Brazil, Mexico and Turkey; money series for Finland, Greece, Ireland and Luxembourg; share price series for Argentina, China, Greece, Portugal, Switzerland and Turkey.

Table 1. Summary of the results in terms of output.

	S1 German-leading	S2 UK-leading	S3 free-floating	S4 Taylor rule	S5 Italy out
Austria	**higher**	*lower*	**higher**	*lower*	negligible
Belgium	*lower*	**higher**	**higher**	*lower*	negligible
Finland	**higher**	**higher**	**higher**	**higher**	negligible
France	*lower*	**higher**	*lower*	**higher**	negligible
Germany	*lower*	*lower*	**higher**	*lower*	negligible
Greece	**higher**	*lower*	**higher**	*lower*	negligible
Ireland	**higher**	**higher**	*lower*	*lower*	negligible
Italy	*lower*	**higher**	*lower*	**higher**	negligible
Luxembourg	**higher**	**higher**	*lower*	*lower*	negligible
Netherlands	**higher**	**higher**	**higher**	**higher**	negligible
Portugal	*lower*	**higher**	*lower*	**higher**	negligible
Spain	**higher**	**higher**	*lower*	**higher**	negligible

Higher (resp. lower): output is higher (resp. lower) in the world with euro than in the alternative scenario.

Table 2. Summary of the results in terms of prices.

	S1 German-leading	S2 UK-leading	S3 free-floating	S4 Taylor rule	S5 Italy out
Austria	lower/negligible	lower/negligible	**higher**	**higher**	negligible
Belgium	higher/negligible	*lower*	higher/negligible	**higher**	negligible
Finland	*lower*	**higher**	*lower*	lower/negligible	negligible
France	lower/negligible	higher/negligible	*lower*	higher/negligible	negligible
Germany	higher/negligible	lower/negligible	higher/negligible	**higher**	negligible
Greece	*lower*	**higher**	lower/negligible	**higher**	negligible
Ireland	higher/negligible	lower/negligible	**higher**	**higher**	negligible
Italy	higher/negligible	higher/negligible	*lower*	*lower*	negligible
Luxembourg	higher/negligible	higher/negligible	higher/negligible	lower/negligible	negligible
Netherlands	higher/negligible	lower/negligible	higher/negligible	**higher**	negligible
Portugal	**higher**	**higher**	*lower*	*lower*	negligible
Spain	higher/negligible	lower/negligible	higher/negligible	*lower*	negligible

Higher (resp. lower): prices are higher (resp. lower) in the world with euro than in the alternative scenario.

Figures

In all the figures, the following codes are used for the countries: AUT (Austria), BEL (Belgium), FIN (Finland), FRA (France), GER (Germany), GRE (Greece), IRL (Ireland), ITA (Italy), LUX (Luxembourg), NET (the Netherlands), POR (Portugal), SPA (Spain).

Figure 0a. Interest rates: Real data and GVAR forecasts.

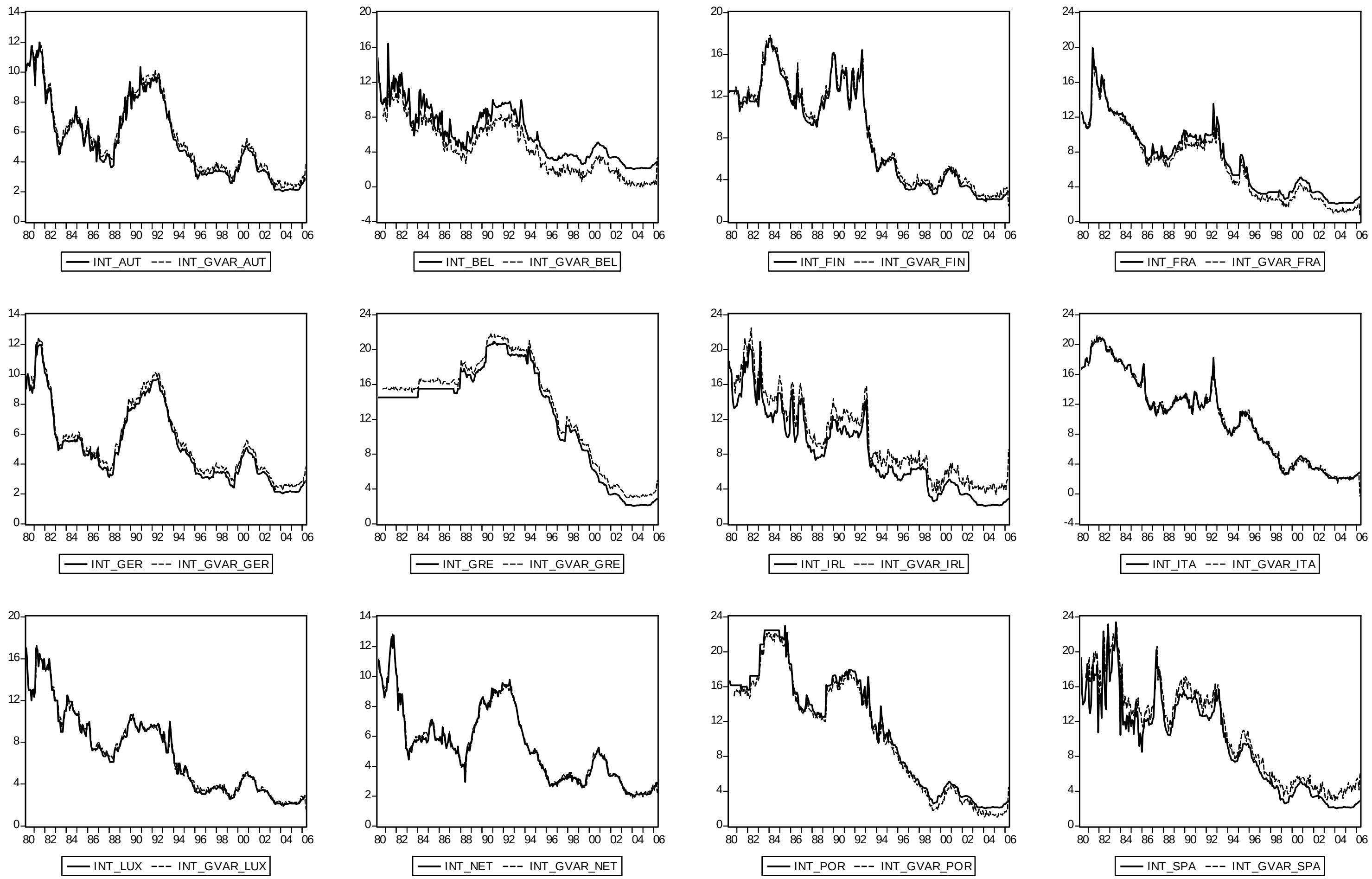


Figure 0b. Industrial production: Real data and GVAR forecasts.

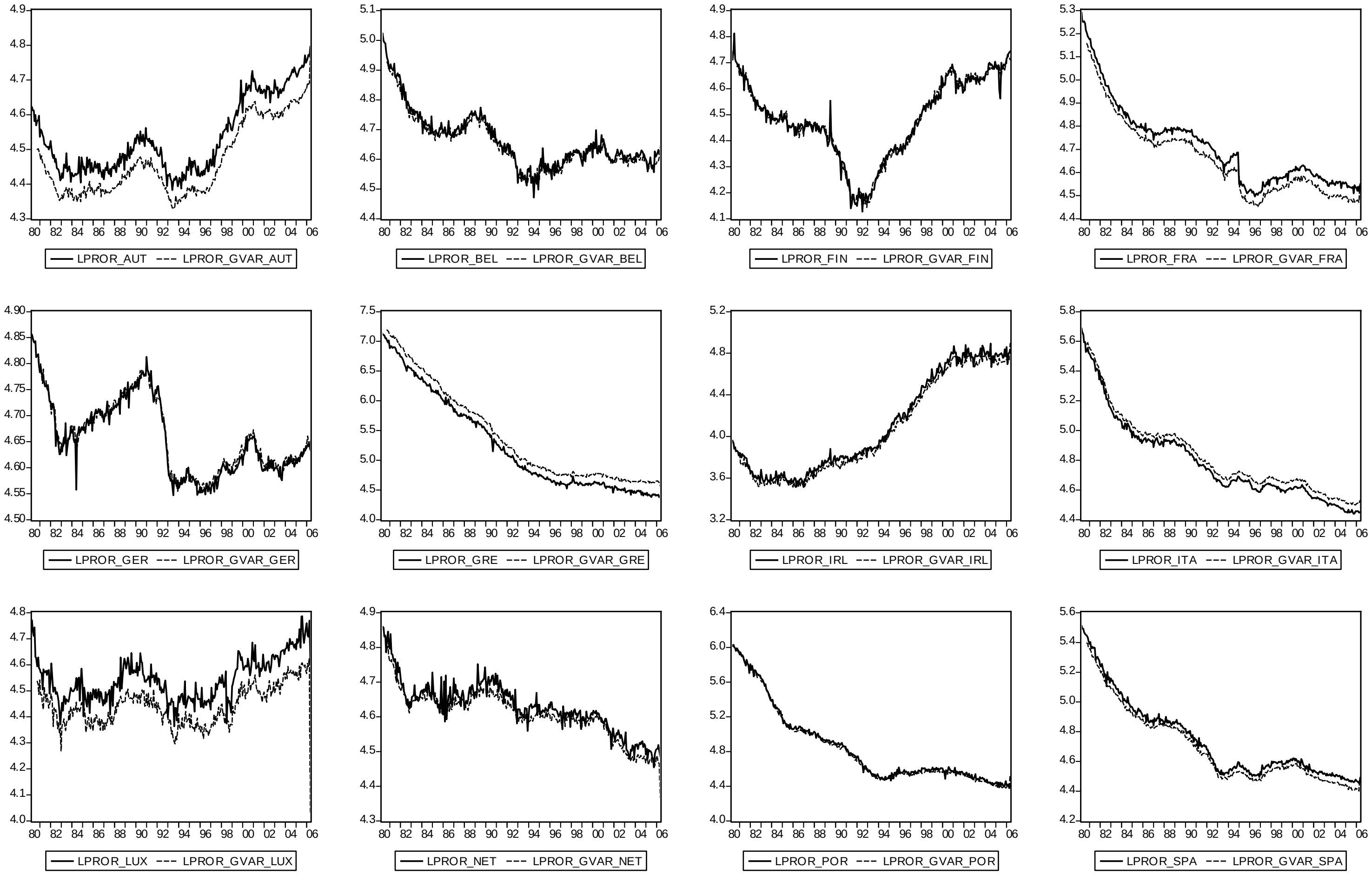


Figure 0c. Consumer price index: Real data and GVAR forecasts.

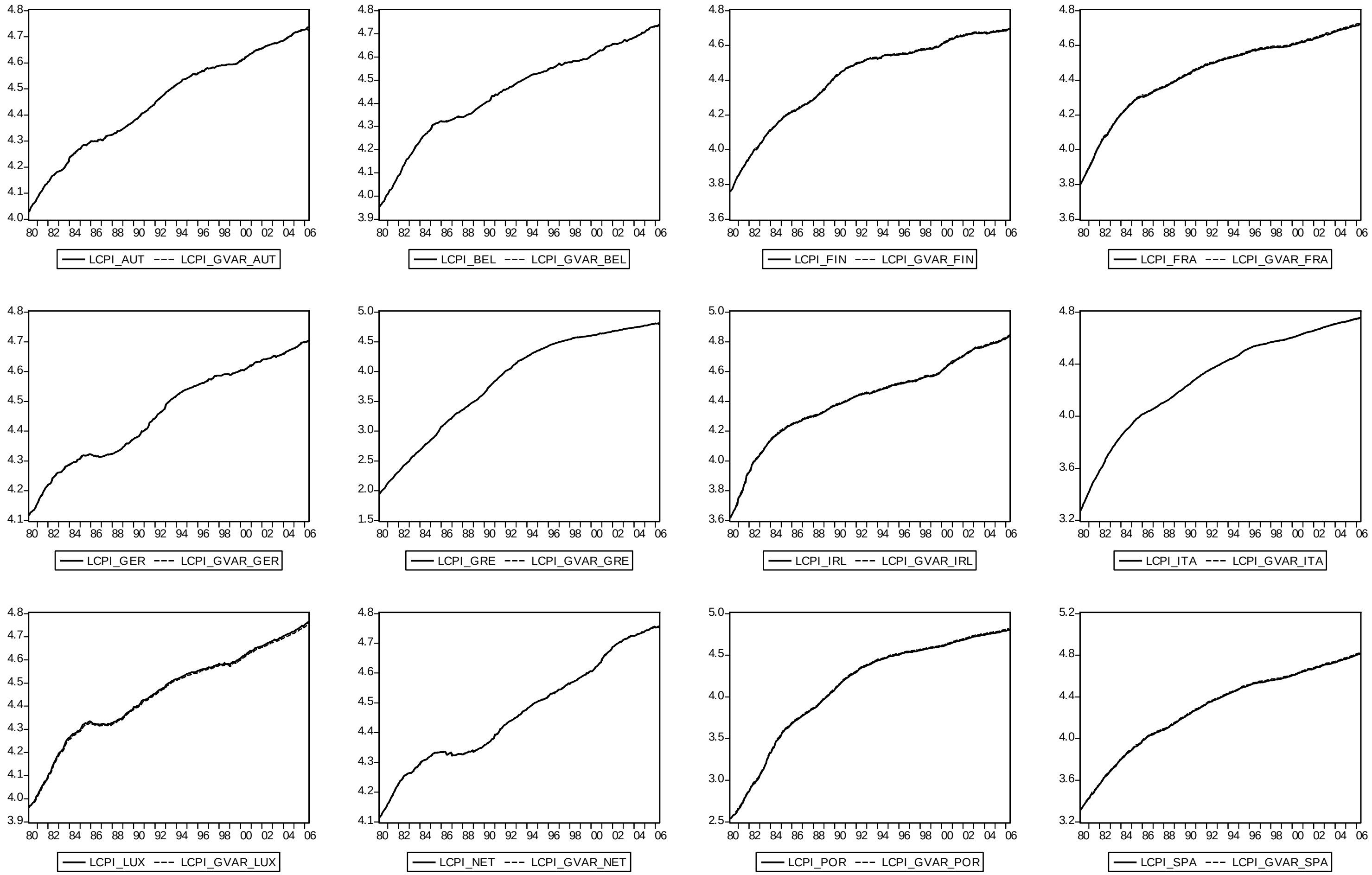


Figure 1a. Scenario 1. Difference between the original GVAR and the German counterfactual GVAR, interest rates (percentage points).

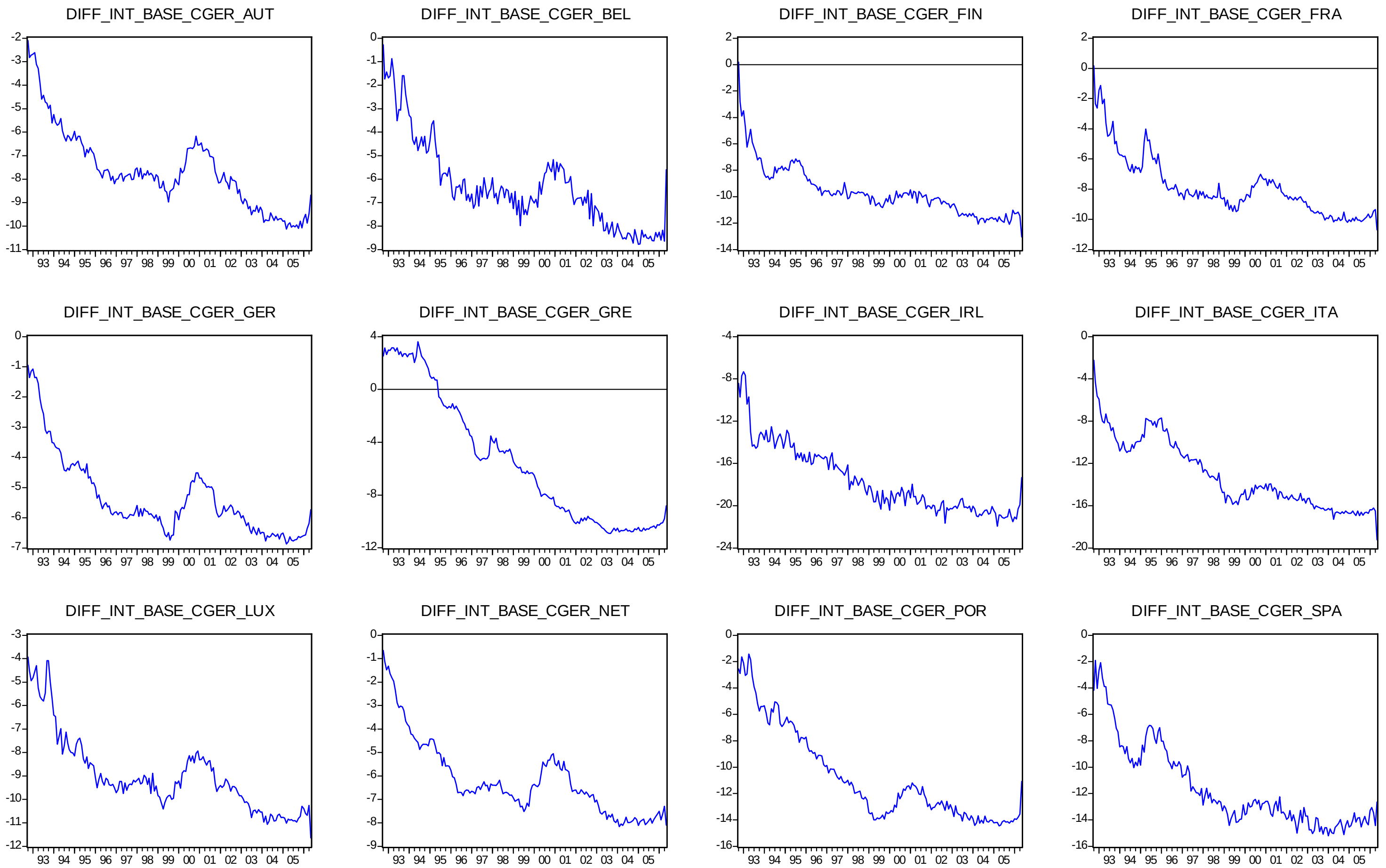


Figure 1b. Scenario 1. Difference between the original GVAR and the German counterfactual GVAR, industrial production.

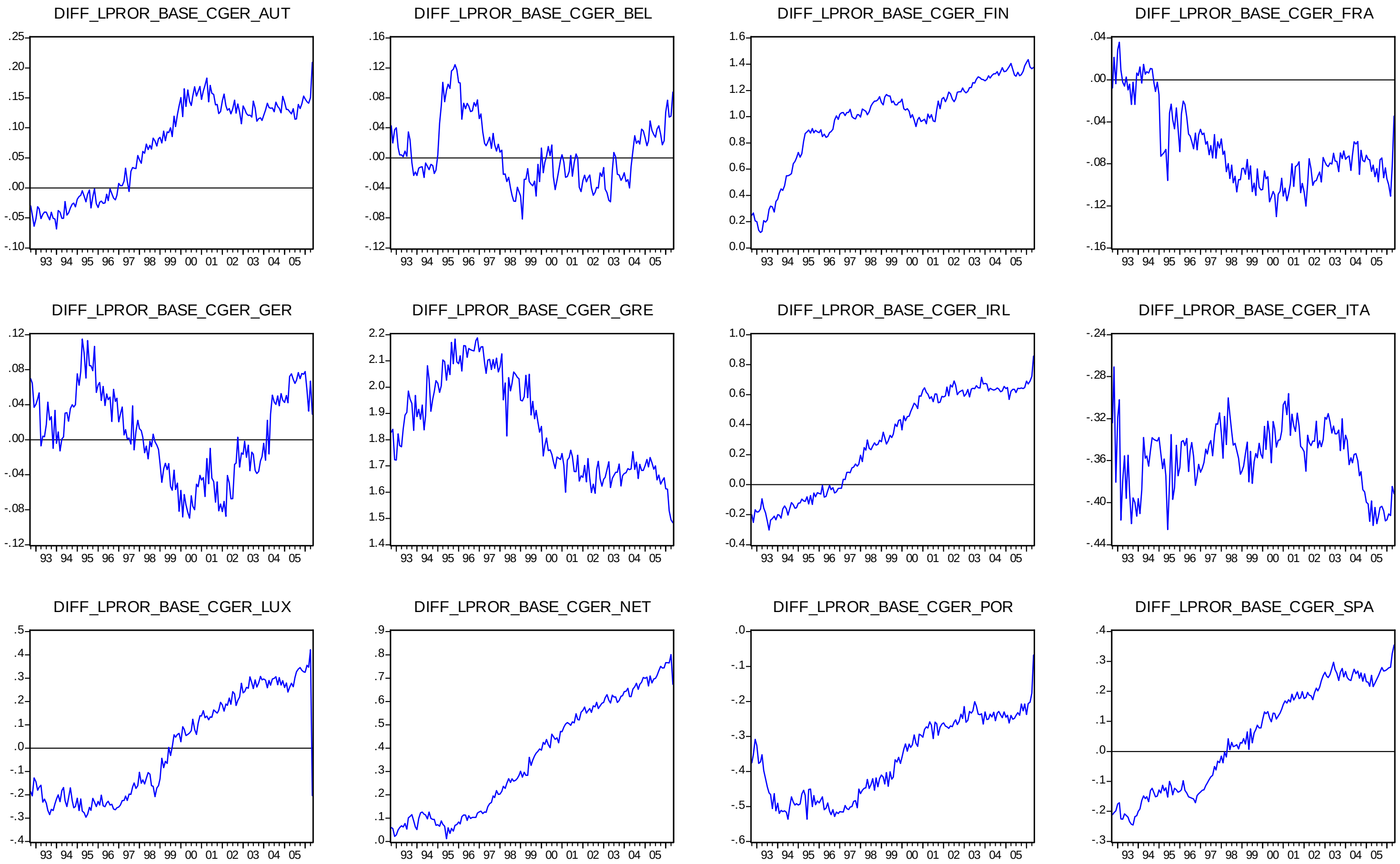


Figure 1c. Scenario 1. Difference between the original GVAR and the German counterfactual GVAR, consumer price index.

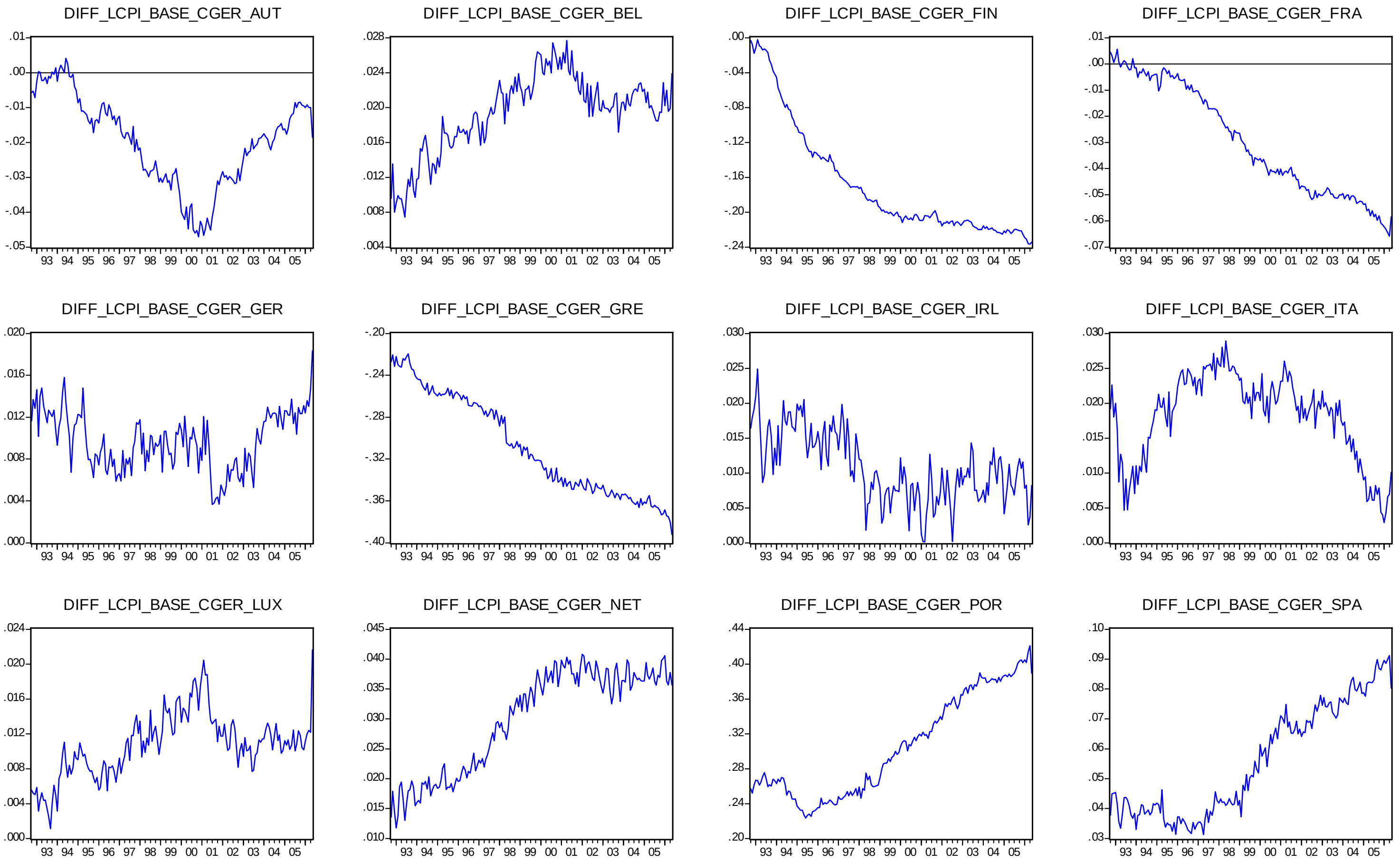


Figure 2a. Scenario 2. Difference between the original GVAR and the UK counterfactual GVAR, industrial production.

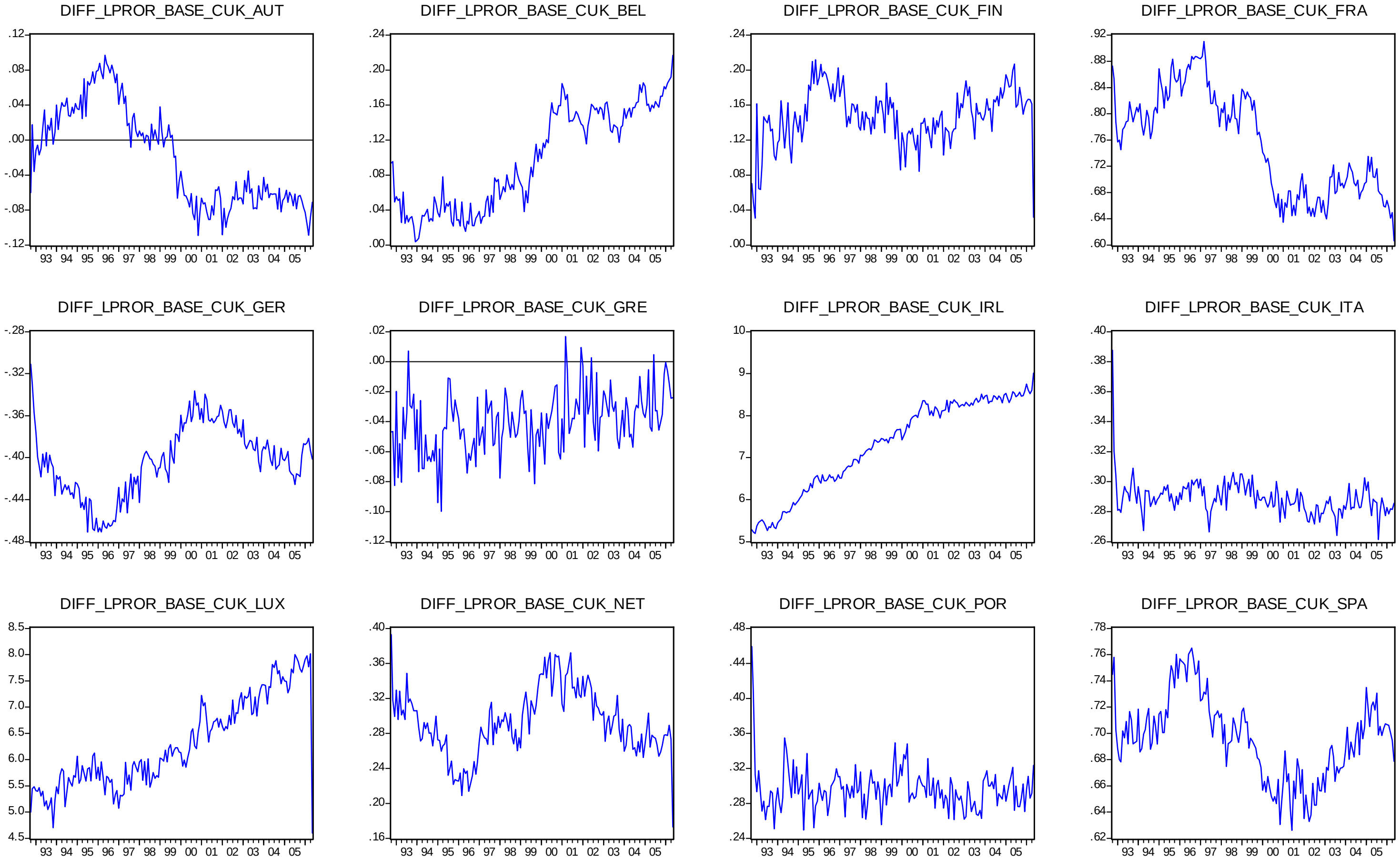


Figure 2b. Scenario 2. Difference between the original GVAR and the UK counterfactual GVAR, consumer price index.

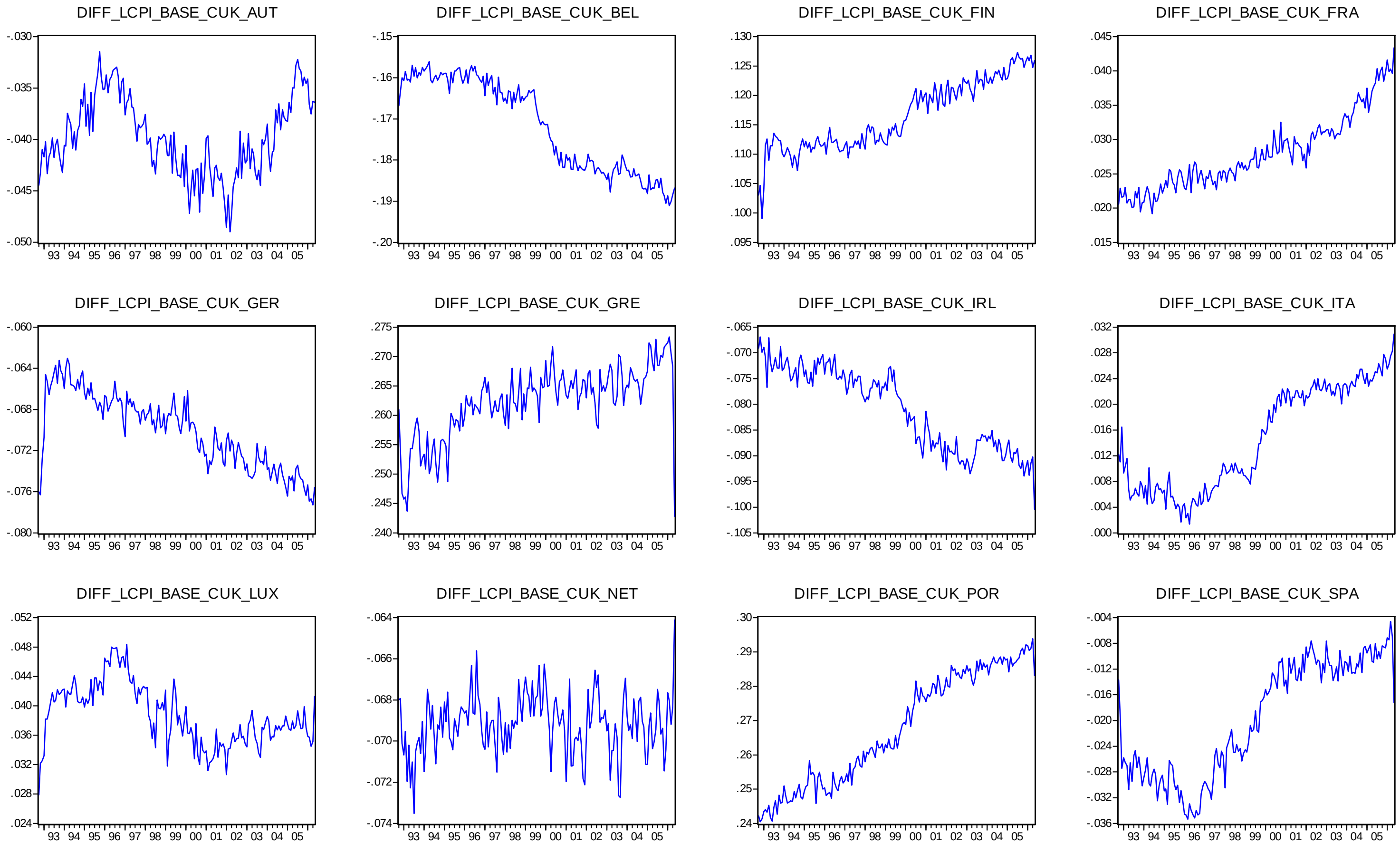


Figure 3a. Scenario 3. Difference between the original GVAR and the "freely float" counterfactual GVAR, industrial production.

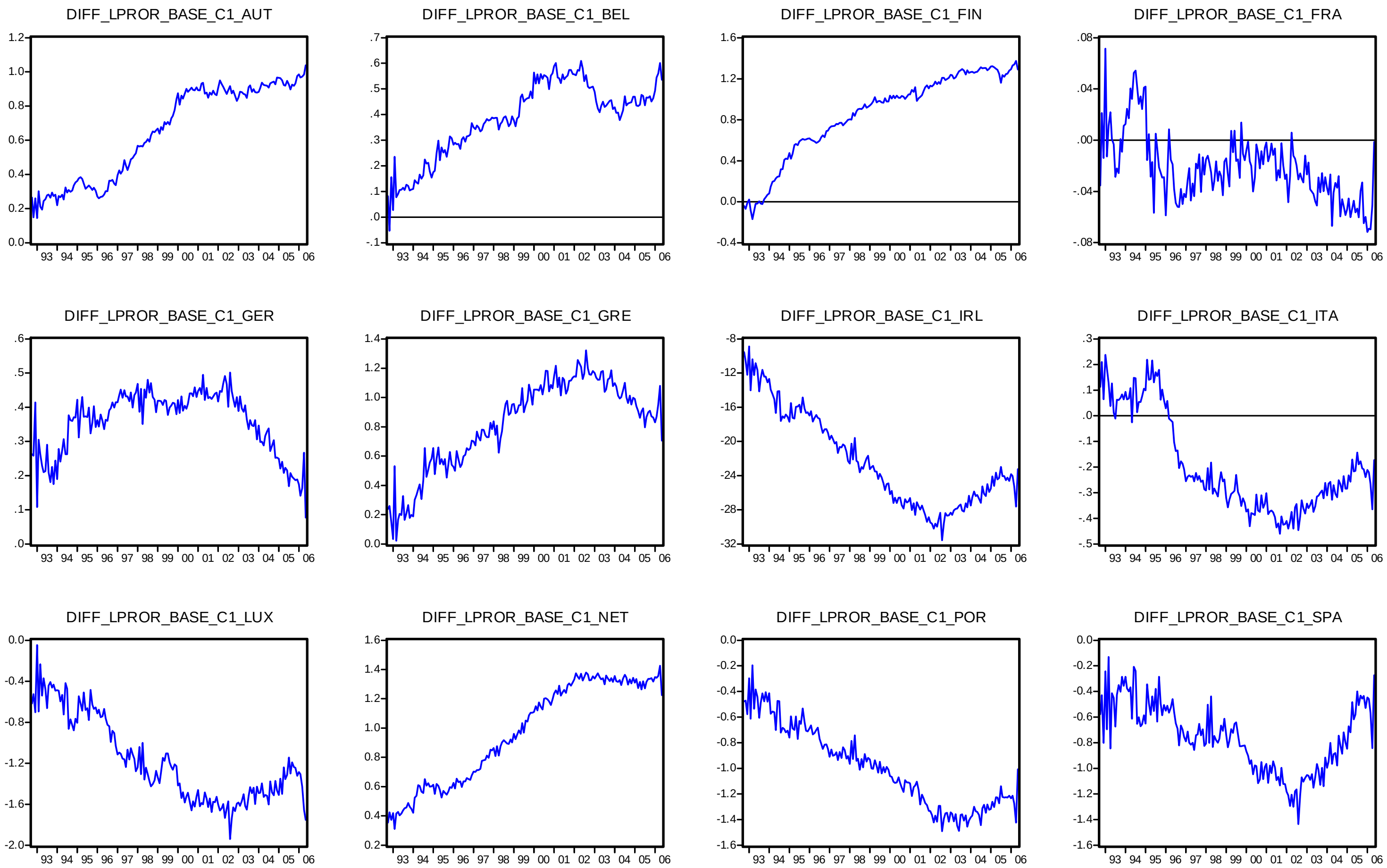


Figure 3b. Scenario 3. Difference between the original GVAR and the "freely float" counterfactual GVAR, consumer price index.

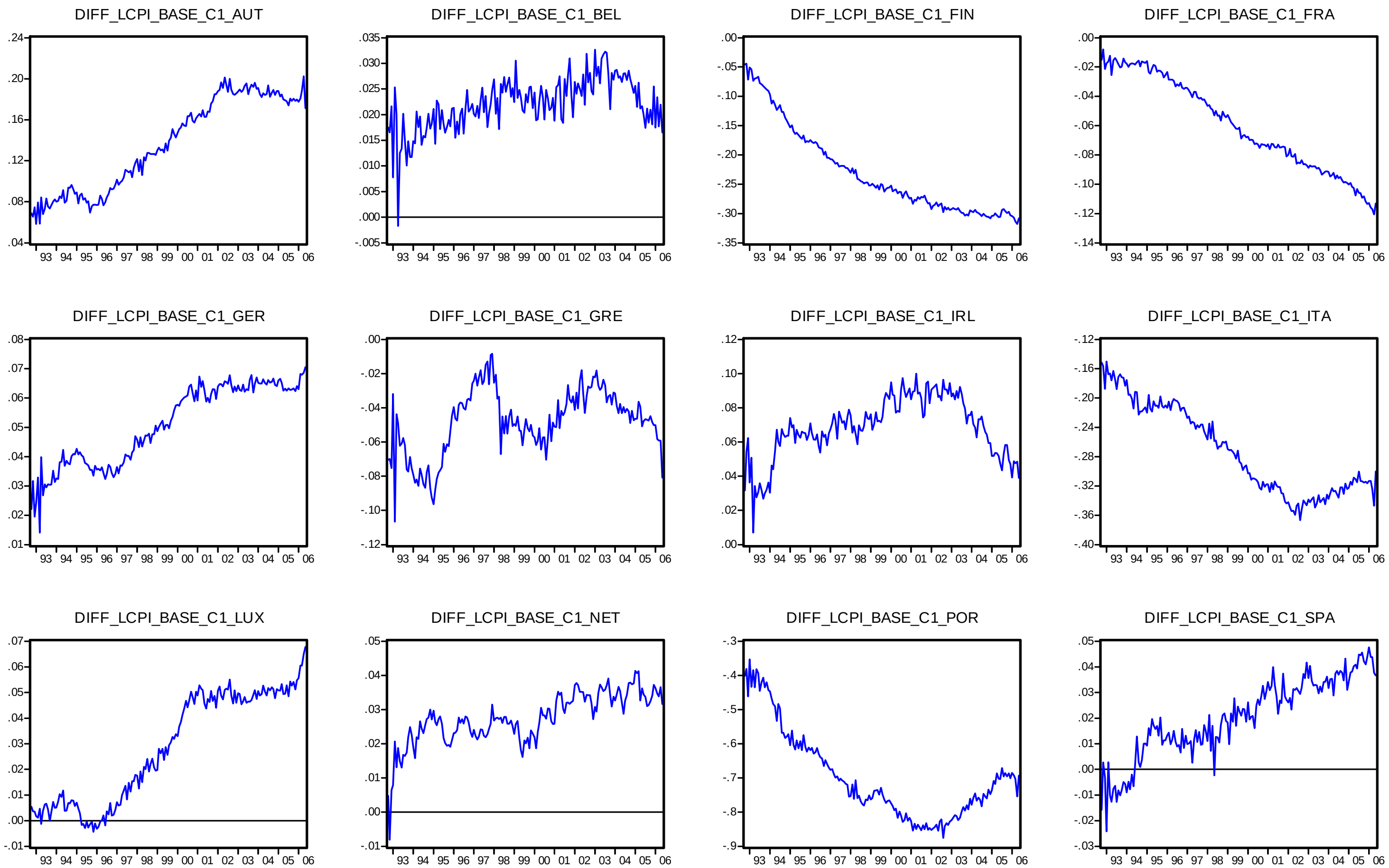


Figure 4a. Scenario 4. Difference between the original GVAR and the Taylor-rule counterfactual GVAR, industrial production.

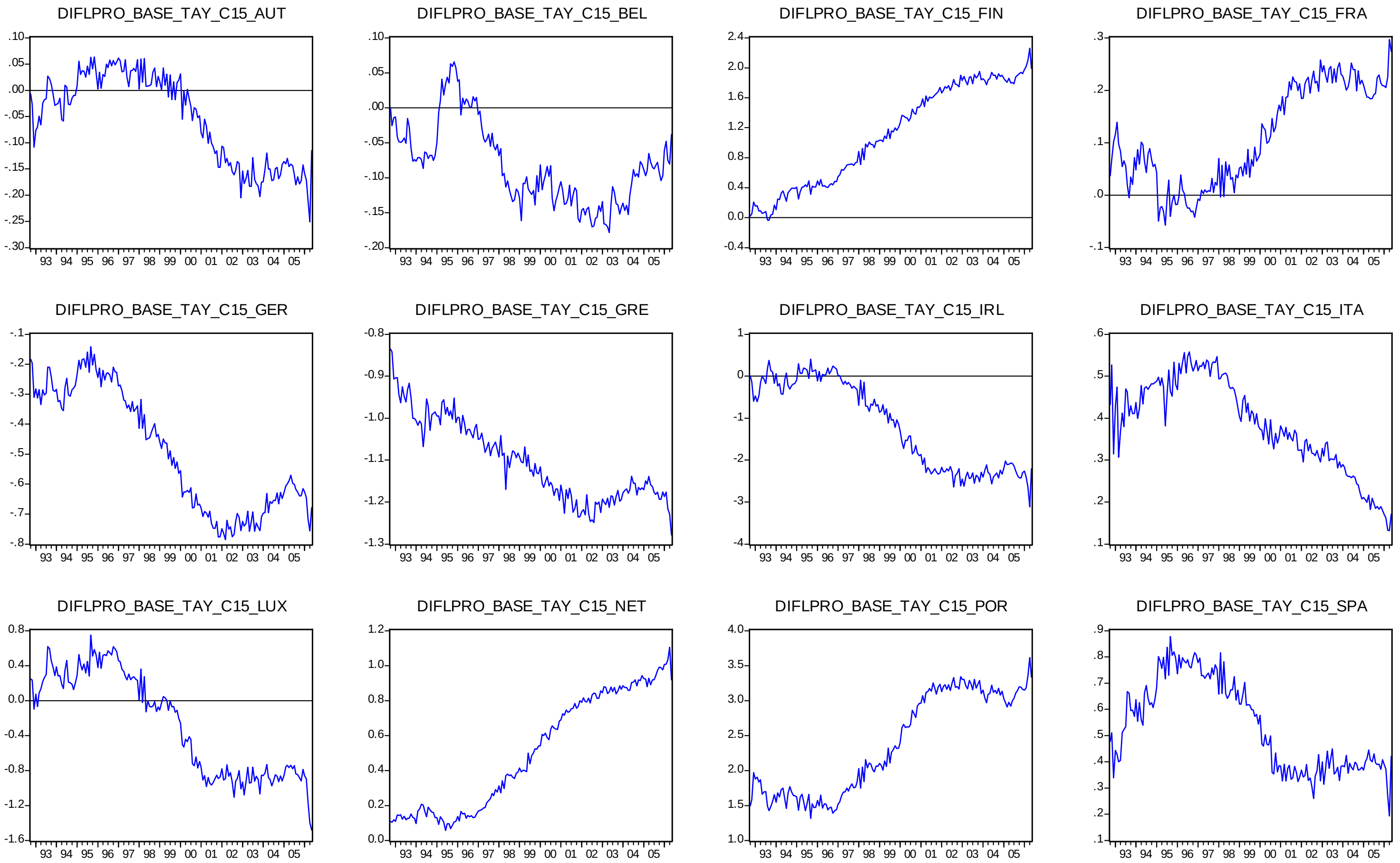


Figure 4b. Scenario 4. Difference between the original GVAR and the Taylor-rule counterfactual GVAR, consumer price index.

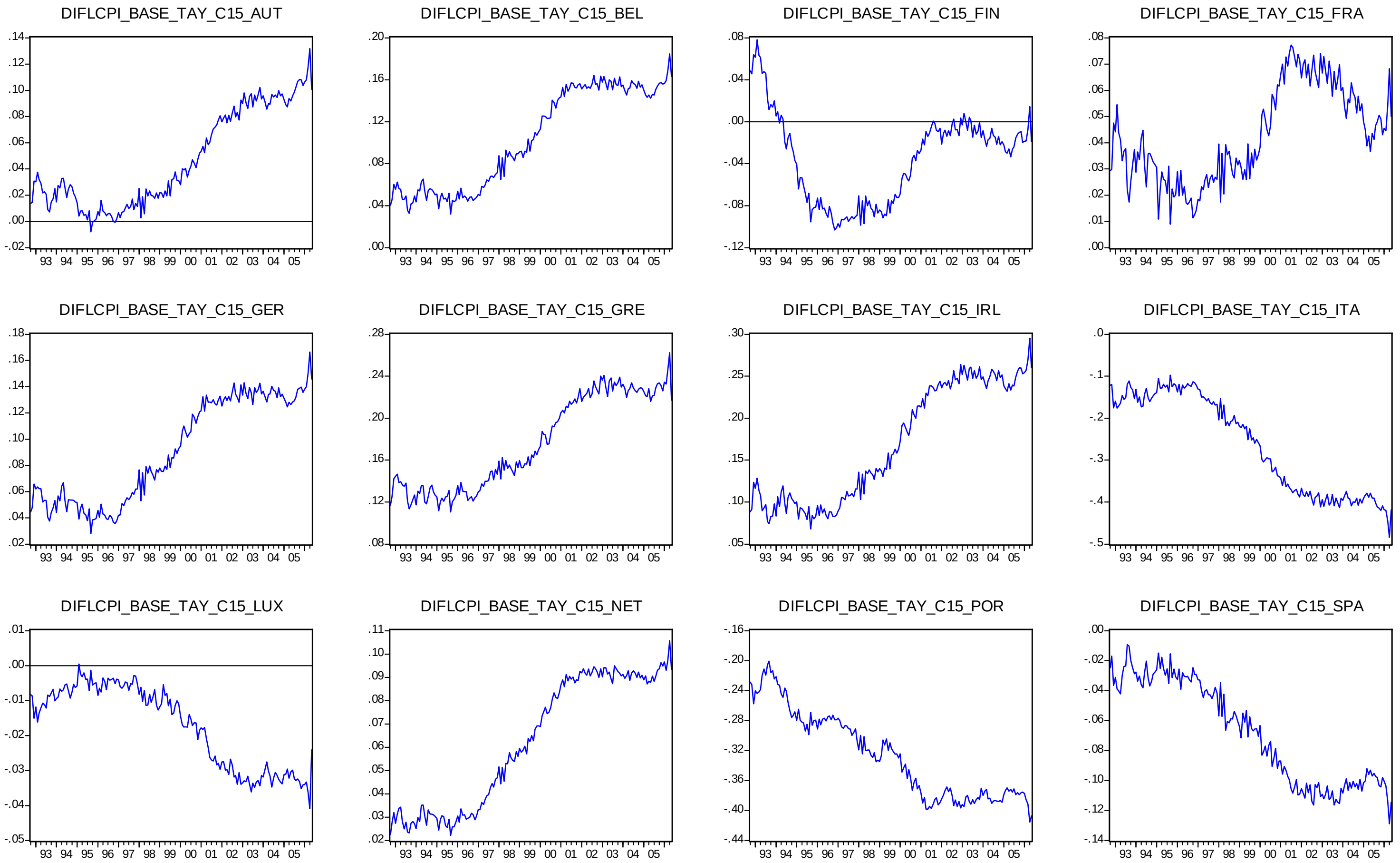


Figure 5a. Scenario 5. Difference between the original GVAR and the Italian counterfactual GVAR, industrial production.

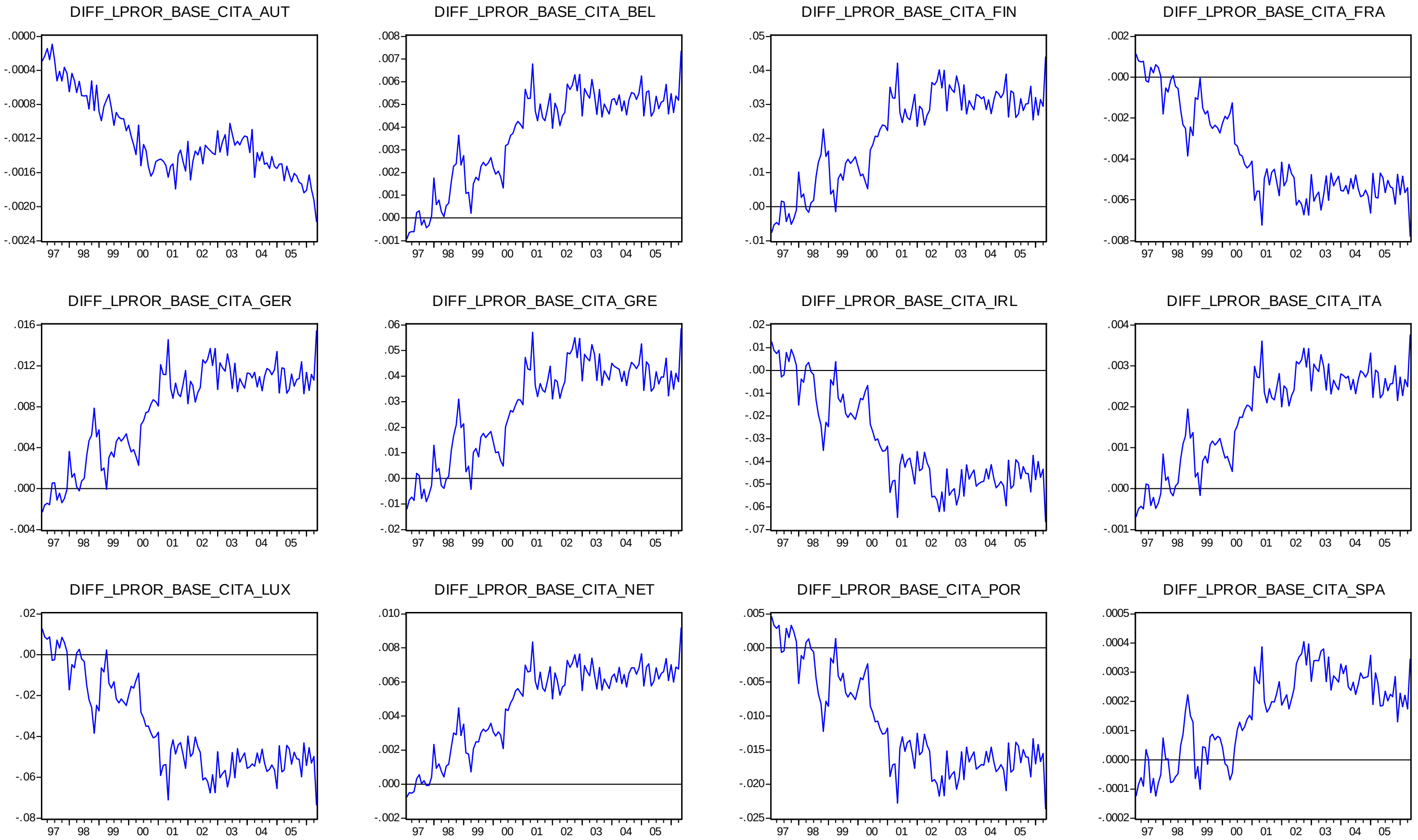


Figure 5b. Scenario 5. Difference between the original GVAR and the Italian counterfactual GVAR, consumer price index.

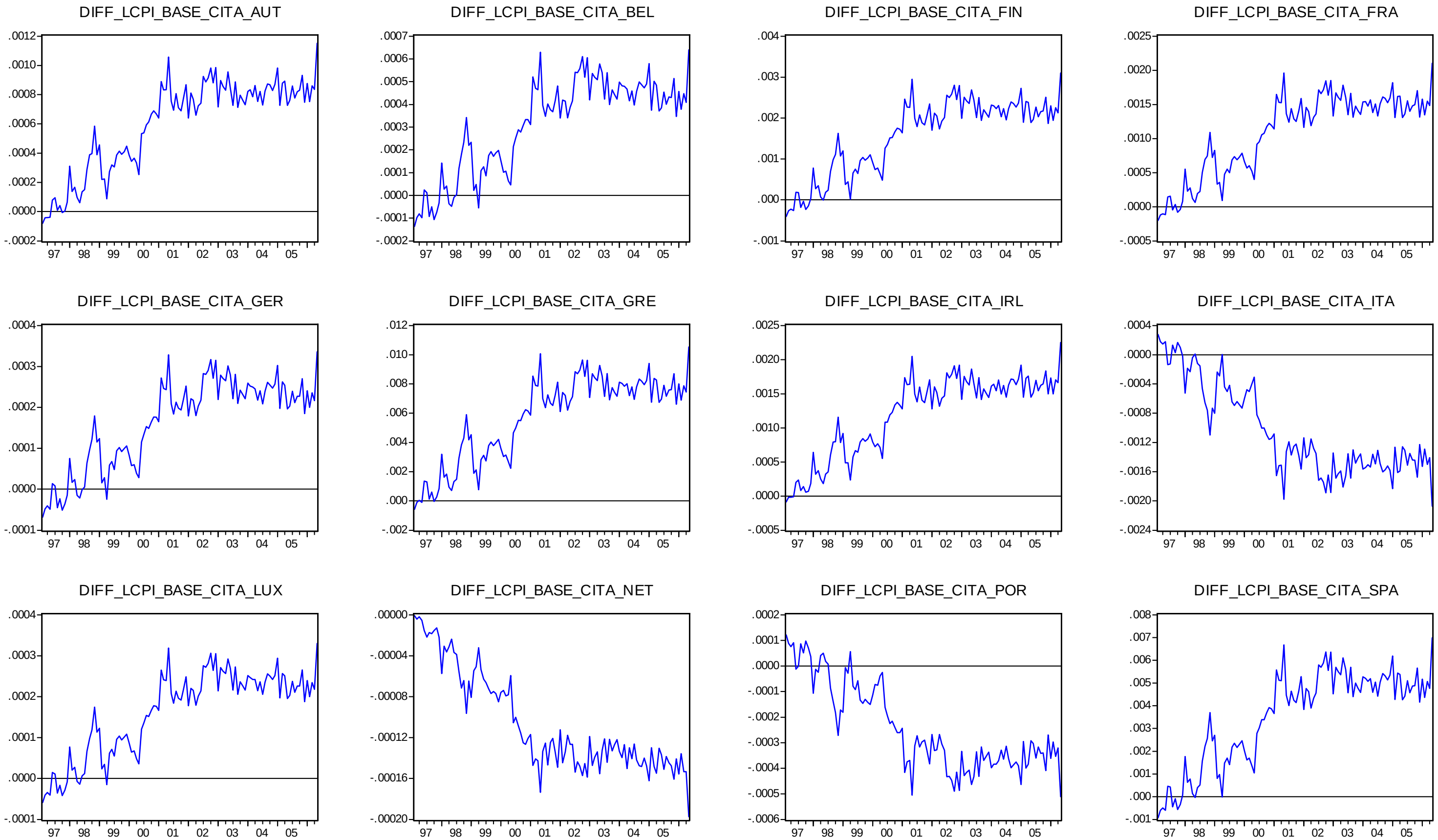


Figure 6a. Summary of the results, industrial production.

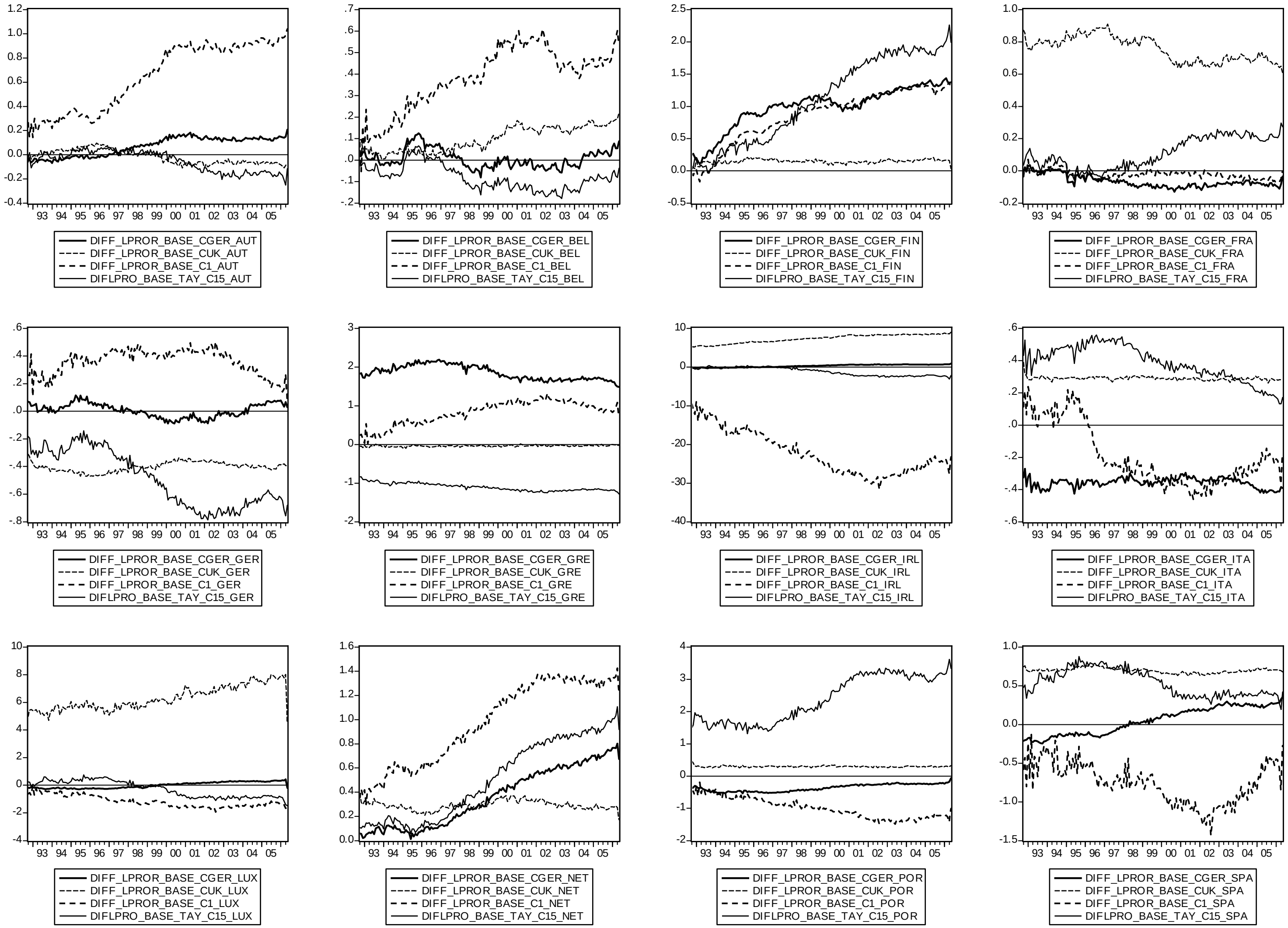
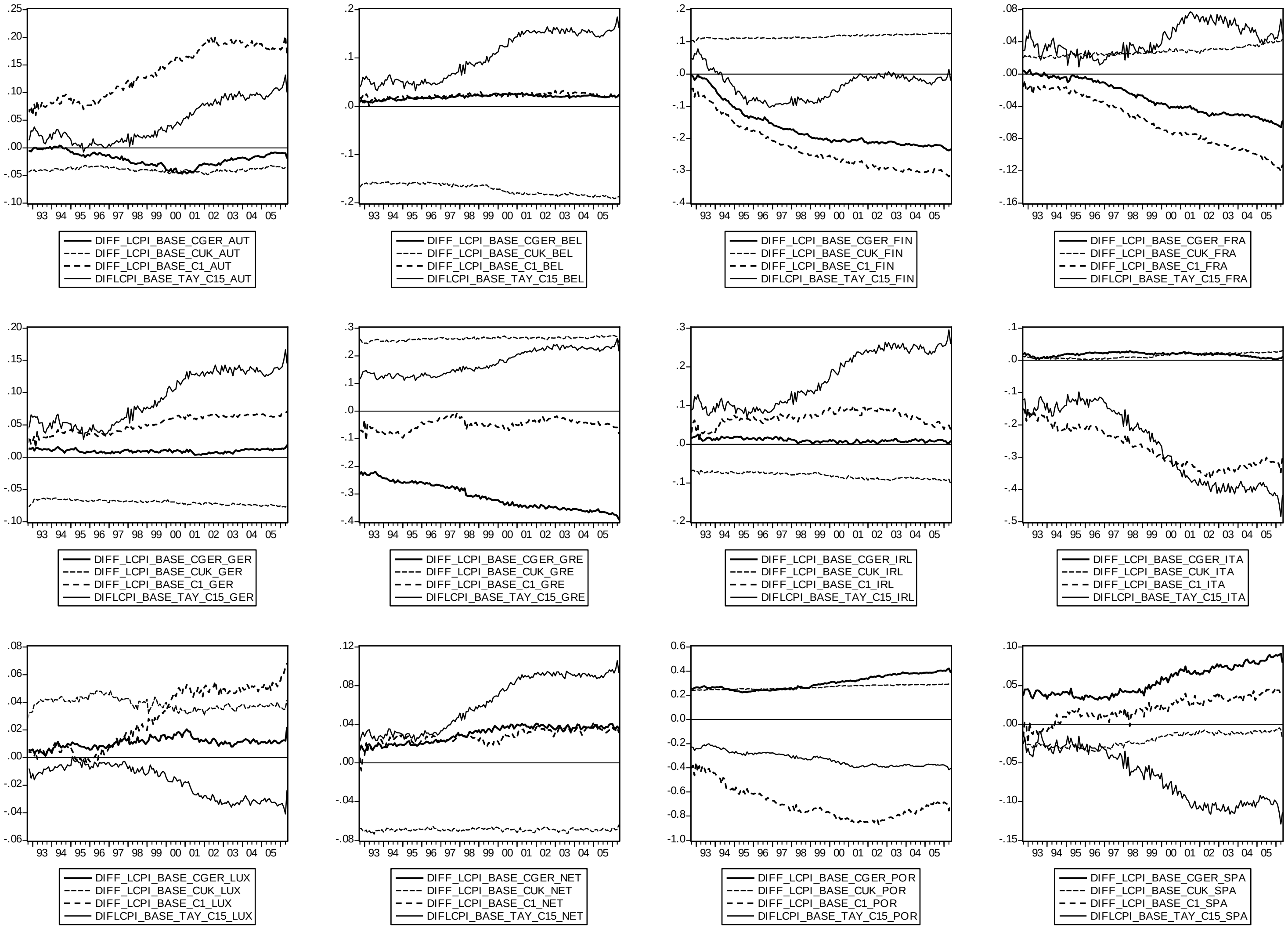


Figure 6b. Summary of the results, consumer price index.



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