Prices and inflation differentials in the Euro area from 1996 to 2002

Jean-Pierre Laffargue[1]

(CEPREMAP and University of Paris 1)

Abstract

The levels and the growth rates of consumption deflators can differ a lot between countries of the Euro area, even after 1999 when these countries adopted a unique currency and central bank. These differences can be decomposed among three components. First, the consumption price can differ from a simple average of the production prices of tradable and non-tradable goods. Secondly, the prices of traded goods can differ between countries. Thirdly, the internal terms of trade change over time. These three differences can be decomposed between more basic heterogeneities between countries, by using a structural multinational model of the Euro area. The two extreme cases that we identified: Germany and Ireland, are thoroughly investigated.

JEL Classification: E31, F15

Keywords: Euro area, Prices differentials, Prices convergence, Balassa-Samuelson effect.

[1] Cepremap, 142 rue du Chevaleret, 75013 Paris, France. Tel : (33) 1 40 77 84 26. Fax : (33) 1 44 24 38 57. Email : jean-pierre.laffague@wanadoo.fr

Introduction

The 1996-2002 period in Europe represents an enthralling experiment, which one can draw from invaluable economic lesson. Twelve European countries co-ordinated their monetary policies more and more to lead in January 1999 to a common currency and monetary policy, supervised by a unique central bank. The relative evolution of prices and the inflation rates during such a period are a source of exceptional information on the extent and the origin of the segmentation and integration of markets, and on the nature of the border effects. Prices can differ between countries, first because of differences in indirect taxation: the Single Act did not involve a perfect convergence of the rates of VAT and excise duties. Then, the prices of tradable goods can differ between nations, even if European markets work efficiently, because they aggregate elementary goods and varieties with different proportions. This heterogeneity in the composition of aggregates can change in the course of time and is also present in the other indices of price. Lastly, non-tradable goods are by definition not subjected to the convergence process resulting from international trade and arbitrage. However, the European structure of these prices is subjected to powerful, even if indirect, mechanisms. The most traditional explanation of this structure rests on differences in productivity and productivity growth between sectors, the so-called Balassa-Samuelson effect. However, other explanations exist, for instance the differences in consumers' preferences or in the demand by other agents and in the policies of income redistribution, the heterogeneities of the labour markets, and the choices of parities for the former national currencies relative to the euro. Lastly, changes in the monetary policy of the European Central Bank (ECB) or in the international environment can modify the price structures in Europe.

Three prices must be examined in priority: the deflator of households' consumption[1], the added value price of the tradable good and the added value price of the non-tradable good[2]. We started by building data for such prices, which can be compared over time, but between countries too, out of the annual national accounts of the OECD and from an evaluation by this institution comparing prices between

industrialised countries for the year 1990[3]. We also got from this computation, evaluations in constant euros of the main economic aggregates (added values and household consumption), that are also comparable over time and between countries.

The average inflation rate of the consumption deflator over the 1996-2002 period for the whole of the Euro area was of 1.79% per year. We removed from our entire price's series a trend having this growth rate and being worth 0 in 1999. The economic comments, which will be made later, will be clearer on these corrected prices than on the original ones. Indeed, we are not interested in this paper so much in the European inflation as in the inflation and prices gaps between European countries.

The paper starts with an examination of economic data considering simple theoretical and partial equilibrium considerations. Section 1 considers the deflator of households' consumption and its rate of variation for the various countries of the Euro area. We can observe a convergence of the inflation rates and the price levels in the years, which preceded the setting-up of the euro. On the other hand the rates of inflation slightly diverged after 1999 while the convergence of prices stopped. Then, one bursts the evolution of the deflator into three components: the evolution of consumption taxes, that of the price of the tradable good and that of the internal term of trade (the ratio of the prices of the non-tradable good to the tradable one). Section 2 shows that prices of the tradable goods in Europe slowly converged to one another although their dispersion remained strong in 2001. On the other hand we do not observe any convergence for the prices of non-tradable goods, the dispersion of which was higher than for the tradable goods. Section 3 compares the internal terms of trade with the ratios between the relative productivities and the relative labour costs in the two sectors. The main result, consistent with the analyses by Balassa and Samuelson, is the parallelism between the evolution of the internal term of trade on one hand and of the ratio of the unit costs of production in both sectors on the other hand. In most cases, the price of the non-tradable good increased more quickly than the price of the tradable good. However, we observe a quasi-constancy of their ratio for Greece and a fall in Germany.

To continue the analysis we built a simulation dynamic model of the 11 countries of the Euro area (we excluded Luxembourg). The inverted simulation of the model, in such a way that it reproduces the economic history of Europe over the period 1996-2002, makes it possible to identify the structural or temporary shocks, which hit the unobservable exogenous variables over the period. These shocks can hit total productivity, monetary policy, the world demand, etc., and they all have clear economic meaning. Then, the direct simulation of the model, without any shock, defines a reference steady state. The simulation with the totality of the computed shocks reproduces the evolution observed in Europe from 1996 to 2002. We then carry out a series of direct simulations of the model such that we introduce in each of them only one shock. This shock can have hit the German economy, or the monetary policy of the ECB, or the rest of the world. Thus, we are able to break up each feature of the evolution of the German economy, for example the fall of its internal term of trade, in the contribution of each of these shocks. The kind of results, which we obtain, evokes those of growth accounting, with the difference that our accounting rests on a general equilibrium model and not on a simple production function. The direct simulations we make also give the extent of the diffusion of German shocks to the other European countries, as well as the impact of the shocks hitting these countries on Germany.

Section 4 applies this methodology to Germany. This country was characterised by a weak inflation. This inflation was lower for the tradable good than for the consumption deflator and for the non-tradable good than for the tradable good. The higher increase in the consumption price resulted from the fact that German households bought goods the prices of which increased more quickly than the average price of the goods, which were domestically produced. If we remove this feature from the simulation of the model, the inflation rate of the consumption deflator becomes weaker. It can be broken up into a decrease in the price of the tradable good and a drop in the internal term of trade. The evolution of indirect taxation did not play any durable role. Most of the decrease in the price of the German tradable good came from shocks hitting the other countries of the Euro area and the rest of the world, the effects of which were mitigated by a relatively expansionary monetary policy of the ECB. The decrease in the internal term of trade over the period is unusual among industrialised economies.

It resulted from the relative evolution of the productivities in the non-tradable and tradable sectors in Germany (a reverse Balassa-Samuleson effect) and of an excessive value of the mark at the time of the definition of European parities. The fiscal, monetary and demand shocks did not have significant durable effects.

Section 5 carries out a similar exercise for Ireland. The consumption deflator increased faster in Ireland than for the European average. Inflation was weaker for the non-tradable good than for households' consumption and was still lower for the tradable good. The higher increase in the consumption price can be explained largely by a strong progression in indirect taxation. It was also because Irish households bought goods the prices of which increased more quickly than the average price of the goods, which were domestically produced. Most of the slow progression of the price of the Irish tradable good came from shocks hitting the other European countries and the rest of the world, the effects of which were mitigated by a relatively expansionary monetary policy of the ECB. The rise in the internal term of trade resulted from the under-evaluation of the Irish pound in 1996, of strong gains in productivity in the tradable good sector (the Balassa-Samuelson effect) and of a decreasing (but still important) wages moderation. These forces were slowed down by the progression of the supply of labour, resulting from the immigration of Irishmen who were installed abroad and from a progression in the activity ratio, and by the evolution of autonomous demand.

The equations of the model are given in the appendix.

1. The deflator of households' consumption

The values of the consumption deflator and of its rate of inflation are given in the Tables 1 and 2 for the period 1996-2002. Looking at both the levels of prices and their rates of variations is important. Actually, a difference in the rates of inflation between two countries is compatible with a convergence

of their levels of price and the absence of convergence of prices between two countries can result from rates of inflation having close values.

PUT TABLES 1 AND 2 HERE

The tables also include the averages and the standard deviations of the price levels and the inflation rates, computed each year across the whole set of countries of the Euro area. These two indicators were calculated by a simple average, without balancing by the sizes of the countries. We can make the following observations:

- European inflation dropped gradually during the three years, which preceded the setting-up of the euro. It increased gradually afterward.
- The dispersion of the rates of inflation in Europe strongly decreased during the period preceding the setting-up of the euro and until the year of this setting-up. It increased afterward[4]. A possible explanation of this contrast is that the national central banks adopted specific national monetary policies the objectives of which were the convergence of the inflation rates. Then, the common monetary policy that the ECB carried out, resulted in a reduction of this convergence, which was somewhat artificial. We can also notice that the dispersion of the inflation rates in Europe was related positively to their average.
- The dispersion of the price levels in Europe followed a similar movement: a fall from 1996 to 1999, then a light rise.
- If we compute the inflation cumulated over the period 1999-2002, we notice it is particularly low in Germany, it is lower than the European average in Austria, Belgium and France, it is high in Spain, the Netherlands and Portugal and very high in Ireland.
- The price level was especially high in Finland. It was higher than the European average in Germany, Austria, Belgium, France, Ireland and the Netherlands. It was lower than this average in Spain, Greece, Italy and Portugal

We also looked at the data on the consumption deflator in each country, which are published in Penn World Tables, over the period 1996-2000. They are expressed in current dollars, and can be compared internationally. We could identify a group of countries, which have prices approximately equal to

German prices: Austria, Finland, France, at a lesser extent Belgium and the Netherlands. Prices in other countries are significantly lower, mainly in Spain, Greece and Portugal and at a lesser extent in Italy. The differences in prices were higher than those that we calculated before, but the relative positions of the countries are similar.

The Bank Dresdner Kleinwort Wasserstein (DKW) carries out an annual study comparing for the 6 largest countries of the Euro area the prices of branded goods (thus virtually identical in the 6 countries). The price differences between countries decreased in 1999, 2000 and 2001. But the convergence stopped in 2002 and 2003. The differences in prices were particularly high for the goods subjected to excise duties (tobacco, cigarettes), for the goods produced by monopolies and with price elasticities differing between European countries (pharmaceutical products, mineral and for non-tradable goods (movie house tickets). A brake to the convergence in prices is that there do not exist yet wholesales companies active at the European level. The dispersion of prices in the Euro area is about twice higher than in the United States.

Then, we decomposed the consumption price in three elements, which determine its dynamics: the tax rate on consumption, the price of the tradable good and the price of the non-tradable goods. We assumed that the consumption price is a log-linear function of these three components and we obtained the following relationship for an arbitrary country j.

$$\ln(pc_j) = \ln\left(\frac{1+tc_j}{1+\overline{tc}_{Ge,1995}}\right) + a_j + b_j \ln(pt_j / q_j) + (1-b_j)\ln(pn_j) \qquad (1)$$

pc_j, pt_j and pn_j respectively represent the prices of consumption, of the tradable good and of the non-tradable good. tc_j is the taxation rate of consumption. The term $\overline{tc}_{Ge,1995}$ is introduced because each of the three prices is an index, internationally comparable, but being worth 1 in Germany in 1995. q_j is an indicator of the “quality" of the tradable good, which will be commented on later

Equation (1) allows some interesting decomposition of the difference in consumption prices between two countries j and i, that is of the real exchange between these countries. By dividing equation (1) for country j by the same equation for country i, we obtain the following equation:

$$pc_j / pc_i = \frac{1+tc_j}{1+tc_i} \frac{pt_j / q_j}{pt_i / q_i} (q_j pn_j / pt_j)^{1-bj} (q_i pn_i / pt_i)^{-(1-b_i)} \exp(a_j - a_i) \qquad (2)$$

The right-hand side of this equation includes: 1) The price ratio of the tradable goods corrected by their qualities in the two countries; 2) The price ratio between the non-tradable good and the tradable good in each of the two countries, that is the ratio of the internal terms of trade in the two countries; 3) The ratio of the tax on consumption in the two countries.First, we will examine the prices of the tradable goods, then the internal terms of trade in each country of the Euro area.

2. The prices of the tradable goods

We will assume in this paper that the law of one price holds for the tradable good in Europe, with an amendment: each country produces a tradable good with an exogenous specific quality q_j. However, all these goods are perfectly substitutable. We thus have the following relation between the prices of this good in two arbitrary countries i and j of the Euro area[5]:

$$pt_i / q_i = pt_j / q_j \qquad (3)$$

The prices of the tradable good appear in Table 3. The table shows that the prices of tradable goods in Europe slowly converged to one another although their dispersion remained strong in 2001.

PUT TABLE 3 HERE

One expects that the quality of the tradable good, and thus its price, are lower and increase faster in the least advanced European countries. Indeed, the countries where the tradable goods had the lowest prices were (in the order increasing prices): Greece, Spain and Portugal. However, Spain had a lower price than Portugal and this country had a price, which was almost equal to that in Belgium. The country where the price of this good was highest was Germany. If one classifies the countries by increasing inflation rates we get Portugal first, then Italy, the Netherlands, Greece and Germany. Thus, the economic law that we have just suggested seems to have some validity but with notable exceptions[6].

We also examined the price of the non-tradable good in each country of the Euro area. Of course, there is not any direct equalising mechanism of prices for these goods. However, we thought that this comparison could give a useful benchmark for the previous comparison. Table 4 shows that the dispersion of prices between countries of the Euro area is much higher for the non-tradable than for the tradable goods. The convergence of the prices of non-tradable goods was fast until 1999, then their dispersion remained approximately constant. The prices of the non-tradable goods grew at a much higher rate than the prices of tradable goods. There is however a significant exception to this result, which is Germany where the price of the non-tradable good dropped much.

PUT TABLE 4 HERE

Heston et al. (1995) compared the similarity of the prices of tradable and non-tradable goods in 1985 for 64 countries. They showed that the discrepancy between countries was less for the prices of tradable goods than for the prices of non-tradable goods. They also showed that the differences in the prices of the non-tradable goods were of the same order of magnitude as the differences in the prices of the tradable goods, for countries with the same level of development. On the other hand, for countries with different levels of development they observed that the prices of non-tradable goods were definitely lower in the least advanced countries. This link between the levels of the prices of non-tradable goods and the incomes per capita was consistent with the analysis by Balassa and Samuelson.

Rogers (2001, 2002) used prices appearing in the computation of the cost of living in the countries of the Euro area for the managers of multinational firms, published by Economist Intelligence Units. He concluded that some convergence occurred to some extent over the 1990-2001 period for the prices of tradable goods (in 2001, price dispersion was about the same in Europe as between American cities). This convergence resulted from corrections of inadequate initial parities in the Euro area and for a stronger competition in this zone. On the other hand the dispersion of the prices of the non-tradable goods decreased very little over the period. A significant share in the inflation gaps in the Euro area could be explained by initial differences in prices and the convergence process, which followed. One does not observe that for American cities where the dispersion of prices has even increased, in particular those for housing. The harmonisation of the rates of VAT and the convergence of GDP per capita also contributed to explain the inflation gaps in Europe. Finally Rogers noted that the general level of prices in a country increased with its GDP per capita, which agreed with the Balassa-Samuelson effect.

3. The internal term of trade

Equation (2) connects the differences in the consumption deflator to the ratios of the internal terms of trade. But, how is the internal term of trade in country j determined? To answer this question we will present some elements of the model we used for this paper. Country j has a production of tradable good QT_j given by the following equation:

$$QT_j = AT_j LT_j^{at_j},\ 0 < at_j < 1 \qquad (4)$$

LT_j denotes the employment in the tradable sector and AT_j is the total productivity in this sector. The firms in the tradable sector determine their employment in order to maximise their profits, for a selling price of their product pt_j and a cost of labour wt_j exogenous. We obtain the relation:

$$at_j QT_j / LT_j = wt_j / pt_j \tag{5}$$

The specification of the non-tradable sector is similar to that of the tradable sector. We thus have the equations:

$$QN_j = AN_j LN_j^{an_j},\ 0 < an_j < 1 \tag{6}$$

$$an_j QN_j / LN_j = wn_j / pn_j \tag{7}$$

LN_j denotes the employment in the non-tradable sector, wn_j is the cost of labour in this sector and pn_j is the price of the good it produces. Let us divide equation (5) by equation (7). We get:

$$\frac{pn_j}{pt_j} = \frac{at_j}{an_j}\frac{wn_j}{wt_j}\frac{QT_j / LT_j}{QN_j / LN_j} \tag{8}$$

The internal term of trade depends on the ratio of the costs of labour in the two sectors (it would be equal to 1 if the labour markets were perfect and if the quality of labour were homogeneous between sectors). It also depends on the ratio of the productivities of labour. We can examine whether this relation is in conformity with the facts. Graphs 1 represent for each country the logarithm of the internal term of trade on the one hand and the logarithm of the ratio of the unit costs of labour in the two sectors $\frac{wn_j}{wt_j}\frac{QT_j / LT_j}{QN_j / LN_j}$ on the other hand.

PUT GRAPHS 1 HERE

The graphs exhibit two results. First, the curve representing the ratio of the unit costs of labour is below that of the internal term of trade, with two exceptions. That is compatible with the assumption that the share of wages in the added value is higher in the tradable sector than in the non-tradable one. The exceptions are Ireland and the Netherlands, which means that in these countries the share of wages in the added value is lower in the tradable than in the non-tradable sector. Honohan and Walsh (2002) notice in their analysis of the Irish economy over the 40 last years that in some manufacturing sectors, employment has been relatively low and the productivity of labour has been very high. The reason is that Ireland strongly takes part in the international labour division carried out inside multinational firms. Those have an interest, for example by the choice of adequate transfer prices or of licence fees to overestimate the profits and the production carried out in Ireland to benefit from the low taxation of profits in this country.

Second, the two curves have parallel evolution. The internal term of trade and the ratio of the unit costs of labour increased in all countries of the world, except in Germany where it decreased and in Greece where it hardly moved. We could add that the ratio of labour productivity in the tradable and the non tradable sectors, remained approximately unchanged in Germany, but increased in the other countries, sometimes by much (France, Ireland). So, the Balassa-Samuelson effect could exist in most European countries but not in Germany.

Rogers (2001) also noted a strong correlation between the internal term of trade and the ratio of labour productivities in the two sectors over the period 1995-1999. Canzoneri et al. (1999, 2001) noticed that equation (8), plus the assumption that the ratio of the costs of labour in the two sectors follows a stationary process, implies the stationarity of the ratio between the internal term of trade and the ratio of the costs of labour in the two sectors follows a stationary process, implies the stationarity of the ratio between the internal term of trade and the relative productivities of the two sectors. These authors tested the presence of a unit root in this ratio on a panel of European countries, over the 1973-1997 period, and they rejected this property.

Thus, equations (2) and (8) are a good starting point to analyse the differences in prices and inflation rates between European countries. However, they are only relations of partial equilibrium, between variables that are simultaneously determined. These equations include no variable representing the intensity of national or foreign demands for any of the two goods, and do not allow distinguishing the cyclical causes from the more structural ones of inflation gaps between European countries. It is to get over these limits that we will use simulations obtained from a structural model of the Euro area.

4. Analysis of the prices and inflation differentials between Germany and the rest of Europe from 1996 to 2002

The simulation model includes 11 blocks of equations with identical structures (but differing by the values of their parameters and variables) representing the 11 countries of the area (Luxembourg was excluded from the model), and an almost exogenous rest of the world the currency of which is the dollar. Each country has two sectors respectively producing the tradable good and a national non-tradable good. We assume that labour is imperfectly mobile between the two sectors because trade unions exist in each of them and bargain on wages in the interest of the already employed workers. Each country includes a Government sector. The budget policy has a dual effect: a neo-classical one resulting from the existence of distorting taxes, and a Keynesian one because a part of households is constrained on the credit market, which invalidates the Ricardian equivalence. The simulations of the model are made in the neighbourhood of a reference steady state, which reproduces the average situation observed in Europe over the period 1996-2002.

In this section we will use the model to obtain explanations of the evolution of the German economy from 1996 to 2002. In the following section we will carry out a similar analysis for Ireland. The previous descriptive analysis showed indeed that these two countries constituted two extreme cases of the European situations, and that they must thus be examined in priority.

We will explain better our methodology by resorting to some mathematical formalisation. The model can be written:

$$f(y_{t+1}, y_t, y_{t-1}, x_t, x_{t-1}, a_t) = 0 \quad (9)$$

y_t is the vector of the endogenous variables, which all are observable, x_t is the vector of the observable exogenous variables and a_t the vector of the non-observable exogenous variables. These last are, for example, the global productivity of both sectors, the bargaining power of the trade unions in each sector, etc. The number of these variables is equal to that of the endogenous variables. The model has a reference steady state $(\bar{y}, \bar{x}, \bar{a})$, which satisfies the equation :

$$f(\bar{y}, \bar{y}, \bar{y}, \bar{x}, \bar{a}) = 0 \quad (10)$$

We set the observable exogenous and endogenous variables to their actual values over a period starting in 1995 and ending in 2002[7]. Beyond 2002, the values of the observable endogenous variables are set at their actual values in 2002. The reverse simulation of the model then enables us to compute the values of the non-observable exogenous variables from 1996 to 2002.

The procedure to simulate a model in a reverse way is frequently used with large econometric models, which are adjusted on the observations by the setting of slack variables to adequate levels. However, we wish here that the slack variables have clear economic meaning. In a model with rational anticipations like ours, this procedure implicitly assumes that the forecasts by economic agents of the future values of the exogenous variables were always perfect over the period of observation, which is obviously an extreme assumption. Another limit of our method is that we assume that beyond the period of observation, the values of the observable variables are set to their last actual values. That amounts supposing that these variables follow a martingale, which is a strong simplifying assumption[8]. An alternative choice would have been to make these variables gradually converge towards their value

at the stationary reference state. However, the choice of the rate of convergence would have probably been arbitrary and our interpretation would have been more complicated. We however kept this last procedure for the interest rate because the stationary reference value of this variable is the only one, which is compatible with the inflation target of the ECB.

We will examine in this section the values taken by the non-observable exogenous variables of Germany, and will try to interpret them with reference to the evolution of the German economy over the investigated period. It is however possible to go farther. Let us set all the exogenous variables, observable or not, as well as the initial values of the endogenous variables to their reference steady state values, except for an exogenous variable in Germany, for example the total productivity of the tradable sector or the indirect tax rate. We set this last variable to its computed value during the reverse simulation of the model if it is non-observable. If it is observable we set it to its actual value until 2002, then to its value in 2002 afterward. The direct simulation gives the effects of the evolution of this variable on the German economy (in particular on its prices), but also on the exchange rate of the euro and on the European interest rate, and finally on the economies of the other European countries like France. We proceed thus for each exogenous variable of Germany, and for each initial value (observed in 1995) of the German endogenous variables. If the model were linear, the addition of the results of these simulations would give the total effect of the shocks hitting the German economy, first on this economy, then on the exchange rate of the euro and the interest rate in Europe, and finally on the economies of the other European countries. The difference between this sum and the observed history of the German economy could be interpreted as the effects of the shocks hitting the other European countries or the whole European economy (symmetrical shocks), on the German economy. We thus have the means of breaking up, for example, the trend in the price of households' consumption into the contributions of the various shocks which hit Germany, the other European countries and Europe as a whole. Obviously, the model being non-linear, this decomposition is only an approximation. However, the non-linearity of the model being weak, the quality of this approximation is rather good.

A last difficulty with our procedure is that the model was built under the assumption of a single central bank in Europe whereas this one has been active only since 1 January 1999. It can seem unjustified to use the model to analyse the former period when each country had its own national central bank. However, if we excluded this period we would be left with only 4 years of data. In addition, one can think that the shocks computed over the period preceding the introduction of the euro, with a model of which the monetary part was then invalid, will be useful to allow a comparison between the transition period from 1996 to 1999 and the current period.

Identification of the shocks in Germany

PUT GRAPH 2 HERE

Graph 2 represents the logarithms of the prices of households' consumption (pc_Ge), of the tradable good (pt_Ge) and of the non-tradable good (pn_Ge) in Germany. These three prices are indices, which can be compared over time and across countries. We remind that we removed from these indices a temporal trend, equal to 0 in 1999 and with a growth rate equal to 1.79% per year (which is the average inflation rate of the price of the households' consumption in Europe over the period). Thus, a decrease in the indices, like the one that can be observed on the graph, means that inflation is lower than the European average. The graph also shows that inflation is weaker for the tradable good than for consumption and for the non-tradable good than for the tradable one. This last feature is exceptional in Europe.

The second line of Table 5, which gives the taxation rate of households' consumption, shows that the difference in trends between the price of consumption and its two components cannot be explained by changes in this tax.

PUT TABLE 5 HERE

It thus appears that non-tradable and tradable goods that German households consume have an average price which dropped less quickly than the average prices of the non-tradable and tradable goods

nationally produced. The goods produced but not consumed by households can be consumed by the Government, or be a part of investment, or be exported. A part of the tradable goods consumed by German households are imported, and the price of these imports can drop less quickly than the average price of the tradable goods that are produced in Germany. The slower fall of the price of consumption than of tradable and non-tradable goods, is taken into account in the model by the parameter a_Ge, which appears in equation (1). The reverse simulation of the model computes the values taken by this parameter. They are given in the third line of Table 5. We can see that this parameter increased over time.

Graph 2 also shows that the price of the tradable good increased at a slower rhythm than European inflation. But how does this trend differ from those of the same price in other European countries? The reverse simulation of the model shows that the “quality" of the German tradable good, relative to that of the French good (which was normalised to 1), q_Ge given in Table 5, grew slightly over the period. This is consistent with a slower decrease in the price of the German good than of the French good.

The analysis of the internal term of trade in Germany will start by the comparison of the costs of labour in the two sectors. If the labour markets were perfectly competitive, the costs of labour would be the same in the two sectors (with the reservation that the average skill of labour could differ between sectors). To facilitate the comparison of these costs between European countries we removed from each a temporal trend, equal to 0 in 1999 and with a growth rate equal to 1.79%+2.88% per year. These numbers respectively are the average rate of the European inflation of the consumption deflator and the average growth rate of European output over the period. We can see on Graph 3 that these corrected costs of labour decreased in Germany, and that the cost of labour was higher in the tradable sector than in the non-tradable one. What is more significant for us is that the corrected cost of labour dropped more quickly in the non-tradable sector than in the tradable one. This evolution is consistent with the faster decrease in the corrected price of the non-tradable good than of the tradable good.

PUT GRAPH 3 HERE

We still have to examine whether the evolution of the costs of labour resulted from the dynamics of variables appearing in the wages equations of the model or from changes in the value of their constant terms. These terms can be interpreted as measuring the bargaining power of trade unions. We shall notice that the cost of labour in each sector is partially indexed on the price of the good produced by this sector. So, the faster decrease in labour costs in the non-tradable sector could result from the faster decrease in the price of the non-tradable good. The reverse simulation of the model computes the evolution of this bargaining power, jt_0_Ge and jn_0_Ge, which is given in Table 5. We can see that the bargaining power of the unions decreased until year 2000, followed by a return to its initial value (a little above in the tradable sector and below in the non-tradable sector, which is consistent with the faster fall in the cost of labour in this sector)[9].

The analysis of the evolution of the internal term of trade in Germany will continue with the comparison of the global productivity of both sectors (we examined the productivity of labour before). The productivity series were corrected by the removal of a trend, equal to 0 in 1999 and with a growth rate equal to 2.88% per year, which is the average growth rate of the European output over the period. These series, AT_Ge and AN_Ge, are given in Table 5. We can see that the productivity of both sectors increased until 1999 and 2000 then dropped afterward. The growth of productivity was a little higher in the tradable sector than in the non-tradable one. This should have induced a growth in the relative price of the non-tradable good compared to the tradable good, according to the Balassa-Samuelson effect. However, we observe the opposite evolution. We noticed before that the productivity of labour increased at the same rate in both sectors. So, it looks interesting to look at the changes in the shares of labour costs in the added values of both sectors, at_Al and an_Al, which are also given in Table 5. We can see that this share is much lower and increases slower in the non tradable sector than in the tradable one.

We continue the analysis by looking at the parameter representing the share of the expenditure by German consumers devoted to the tradable good (when prices are equal), b_Ge. The reverse simulation of the model computed the values of this parameter, which are given in Table 5. This parameter decreased over time. This movement increased the demand of non-tradable good and should have led to an increase in the relative price of this good. However, this price actually decreased. The increase in the preference for the non-tradable good over the 1996-2002 period was a feature, which could be observed in all the countries of the Euro area. A possible interpretation of this result is the increasing share of the health expenditure in national income. This could result from the income elasticity larger than 1 of this expenditure, from the development of more sophisticated and expensive health care, and from the ageing of the population.

We examined until now the evolution of non-observable exogenous variables. It remains to examine the observable German exogenous variables of the model: labour supply N_Ge, the tax rate on wages tw_Ge, the consumption of Government in tradable and non-tradable goods GGT_Ge and GGN_Ge, the autonomous demand for non-tradable and tradable goods AGT_Ge and AGN_Ge, and the transfers minus other taxes –T_Ge. The consumption of Government and autonomous demands being in constant euros, we removed from these variables the trend of European output (2.88% per year). Transfers being in current euros, we removed from them this trend, plus a second one equal to the rate of inflation in Europe (1.79%). These variables are given in Table 6.

PUT TABLE 6 HERE

The most interesting evolutions are the falls in the taxation of wages and in transfers net of the other taxes, as well as the reduction in the autonomous demand for the non-tradable good. All these movements should bear some responsibility for the fall in the German internal term of trade.

Identification of the symmetrical shocks

PUT TABLE 7 HERE

Table 7 gives the values taken by the most interesting symmetrical shocks, which were computed by the reverse simulation of the model. The first shock, noted pr, measured in points of percentage, bears on the risk premium on the euro. The second shock, noted ecb, measured in points of percentage, represents the difference between the observed value of the European interest rate and the value that would have resulted from the application of the monetary rule of the ECB. This table also give the values taken by the exchange rate of the euro e, its growth rate $\Delta e / e_{-1}$, the inflation rate pi and the interest rate i. These three last variables are in percentage per year.

The ECB became active on 1 January 1999. Thus, the values of ecb before this date only reflect that the average interest rate in Europe was low compared to the average inflation, in 1996 and at a lesser degree in 1997. However, the interest rates set by the national central banks of inflationary countries, like Greece or Italy, were high. The ECB lowered its interest rate in 2002 when inflation tended to increase. We already called this behaviour the relatively expansionary policy of the ECB[10]. The strong risk premium in favour of the euro in 1996 and 1999 resulted from the fact that the interest rate remained low in Europe when the euro depreciated against the dollar. Obviously, the year 1996 would deserve an examination country by country.

Decomposition of the causes of the price differentials of Germany

The preceding paragraphs enabled us to identify the shocks which played a significant role in the economic evolution of Germany. Now, we will carry out a series of direct simulations of the model, by withdrawing these shocks one after another, and by setting the exogenous variables, which are not hit any more to their values in the reference steady state. So, we will be able to identify the effect of each shock on the consumption deflator, the price of the tradable good and the internal term of trade in Germany. Let us start by examining this last variable. The last line of Table 8 gives the observed evolution of the internal term of trade from 1996 to 2002. It decreased steadily over the period, which

was some evolution which can seldom be observed in industrialised countries. The second line gives the reference value of the term of trade when all the shocks have been withdrawn from the economy. The other lines give the contributions of the most significant shocks, expressed in percentage points of the term of trade. The line total sums the effects of all the shocks that they appear or not in the table. It differs from the observed value because relative variations cannot be simply added. We can make the following comments.

PUT TABLE 8 HERE

1. The data base was built in such way that the initial values of the prices of the two goods and of the consumption deflator, that is their actual values in 1995, are equal to 1.074[11]. However, the reference steady state values of these variables are pc_Al=1.057, pt_Al=1.040, pn_Al=0.987. As the price levels determined by the model present the property of hysteresis, the initial values of prices condition their steady state values. However, relative prices do not present any hysteresis. We estimated that the parity of the mark compared to the euro was too high in 1996 and contributed to explain an overvaluation of the internal term of trade and of the mark by 5.38%. This overvaluation decreased over time and was equal to 0.29% in 2002. We thus have a first explanation of the decrease in the internal term of trade.
2. The second explanation was a surprise. We had noticed that the ratio of total productivities in the two sectors fluctuated, with a light tendency for the productivity in the tradable sector to increase faster. The ratio of the shares of labour income in the two sectors also fluctuated, with a downward trend in the tradable sector. The simulation of the model shows that these variations played an appreciable role in the fall of the internal term of trade, by 4.3% over the period. An inverted Balassa-Samuelson effect was thus present in Germany.
3. The lines balance of payments and autonomous demand must be commented on together. They represent demand effects, the total of which contributes to only a slight increase in the internal term of trade[12]. An assumption of the model is that the surplus of the balance of the goods and services plus the net income of capital invested abroad, are used to accumulate foreign assets. So, there is a long-term relation between the surplus of the balance and net

foreign debt. In the reference steady state we adjusted the autonomous demand for tradable good so that the average foreign debt observed over the investigated period can be sustained permanently. We did not make this adjustment on the analysed period. Moreover, over this period the identity of the balance of payments requires the introduction of a residual term, which can be interpreted like transfers abroad. These transfers must be added to the autonomous demand for tradable good to analyse the market equilibrium of this good. To compute the line balance payments of the table we removed this residual term. To compute the line autonomous demand we set the demand for the tradable good to its reference steady state value. It thus seems difficult to make a distinction between the factors identified in these two lines.

4. The diffusion of the shocks hitting the other European countries towards Germany, contributed to an increase in the internal term of trade. On the other hand, the shocks hitting the rest of the world had the opposite effect.
5. Non reproduced results show that the effects of fiscal policy on the evolution of the internal term of trade were weak.

Now to examine the price of the tradable good, we will look at Table 9.

PUT TABLE 9 HERE

The price of the tradable good dropped steadily over the investigated period. The shocks on the other European countries, and to a lesser extent on the rest of the world, were the main cause of this fall. It was slowed down by the relatively expansionary policy of the ECB. The other effects compensated one another, approximately. Fiscal policy hardly played of role.

The fall in the consumption deflator is then easy to understand with the help of the following relation, which is a simple rewriting of equation (1).

$$\ln(pc_j) = \ln\left(\frac{1+tc_j}{1+\overline{tc}_{Al,1995}}\right) + a_j + \ln(pt_j) - b_j \ln(q_j) + (1-b_j)\ln(pn_j / pt_j) \qquad (1')$$

The price of the tradable good and the internal term of trade decreased over the period for the reasons which we have just given. These movements induced a fall in the consumption deflator. The decrease in this variable was however slowed down by the fact that households asked for goods the prices of which increased more quickly than the average of the prices of the goods produced in Germany.

Diffusion of the shocks hitting the German economy towards the other European countries

We will comment only on the diffusion of German shocks towards the exchange rate of the euro, the interest rate in Europe and the economic situation in France. As the tradable goods produced by the various European countries are perfect substitute, our model cannot take into account the structures of the market shares of each European country in its partners. This symmetry implies that we will not learn much by examining countries other than France.

PUT TABLE 10 HERE

The first column gives the values of the reference steady state. Employment is in thousands of people and consumption in billions of constant euros. The interest rate is in per cent per year. The other columns give relative variations in percentage for the exchange rate, prices and consumptions. They give absolute variations in per cent per annum for the interest rate and in thousands of people for employment.

Let us examine the situation after 1 January 1999. The shocks hitting the German economy led to some depreciation of the euro. Results not reproduced here show that that this resulted from an insufficient demand by Germany for the tradable good. This depreciation of the euro had an inflationary effect on France. On the other hand the effects on French employment and consumption

were very weak. They resulted from the opposite effects of the depreciation of the euro on the one hand and the weak demand of the tradable good by Germany on the other hand.

5. Analysis of the prices and inflation differentials between Ireland and the rest of Europe from 1996 to 2002

Identification of the shocks in Ireland

PUT GRAPH 4 HERE

Graph 4 shows that inflation was positive for the consumption deflator, but for a flat over the 1997-1999 period, was zero for the non-tradable good and was negative for the tradable good. The second line of Table 11, which gives the taxation rate of households' consumption, shows that the increase in the deflator consumption can be at least partially explained by a strong increase in indirect taxation.

PUT TABLE 11 HERE

The third line of the table shows that, as for Germany, the goods consumed by Irish households had an average price which increased faster than the average prices of the non-tradable and tradable goods which were domestically produced.

The weak progression in the price of the tradable good is a common feature among European countries. The fourth line of the table shows that the "quality" of the Irish tradable good was slightly lower than that of the French tradable good, with a gap that hardly changed over time.

The analysis of the internal term of trade in Ireland can start by examining the costs of labour. We can see on Graph 5 that the corrected costs of labour increased in both sectors. This progression was faster in the non-tradable sector where labour costs became higher than in the tradable sector in 2001. This evolution is consistent with the observed growth in the internal term of trade.

PUT GRAPH 5 HERE

We still have to examine whether the evolution of the costs of labour resulted from the dynamics of the variables appearing in the wages equations of the model or from changes in the values of their constant terms. The values taken by these terms, which can be interpreted as measuring the bargaining power of the trade unions, are given in the fifth and the sixth lines of Table 11. They show that the bargaining power of the trade unions decreased until the year 1999, then slowly increased. This movement had approximately the same amplitude in both sectors. Honohan and Walsh (2002) explained that the moderation of wages in Ireland resulted from an income policy, with the Government exchanging tax concessions for a more moderate attitude by trade unions. In his comment of these two authors, Blanchard added that wages in Ireland could not increase much faster than in England, because of the mobility of labour between the two countries. However, the increase in productivity was definitely higher in Ireland.

Now, we will turn to the examination of the global productivities of both sectors, which is given in the seventh and eight lines of Table 11. We can see that productivity increased in both sectors until 2000 or 2001 then stagnated afterward. The growth in productivity over the period is definitely higher in the tradable sector than in the non-tradable one. So we find a Balassa and Samuelson explanation of the growth of the internal term of trade. Table 11 also gives the evolution of the shares of the costs of labour in the added values of the two sectors. This share strongly dropped in the tradable sector. That resulted from a long run trend of the Irish economy, which forgoes old labour-intensive sectors to develop modern ones, which are thriftier with this production factor. This evolution can also be interpreted considering the already quoted analysis by Honohan and Walsh, which was that multinational firms have good fiscal reasons to overestimate the added value in their Irish subsidiaries, for example by manipulating their transfer prices.

Now, we will look at the values of the parameter representing the share of the expenditure by Irish consumers devoted to the tradable good, which are given in the last line of Table 11. This parameter

decreased over time. This movement increased the demand of non-tradable good and contributed to the growth of the internal term of trade.

It remains to examine the evolution of the observable Irish exogenous variables of the model: labour supply, the tax rate on wages, the consumption of Government in tradable and non-tradable goods, the autonomous demand for non-tradable and tradable goods, and the transfers minus other taxes. They are given in Table 12.

PUT TABLE 12 HERE

Honohan and Walsh (2002) noticed the big rise in the labour supply in Ireland, which we can observe in the table. This movement resulted from a progression in the activity rate, but also from the coming back from Irish emigrants to their country. Actually, the labour supply in Ireland is very sensitive to the economic conditions in this country, which puts flexibility in the determination of wages and can contribute to the explanation of the fall in the bargaining power of trade unions, noted above. We remind that the average growth rate of GDP was about 10% per year over the 1995-2000 period. Another interesting feature of the table is the rise in the taxation of wages until 1999, followed by heavy falls in 2001 and 2002. Finally, Government consumption and net transfers from the Government increased over the period.

Decomposition of the causes of the price differentials of Ireland

The preceding paragraphs enabled us to identify the shocks which played a significant role in the economic evolution of Ireland. Now, as in the previous section, we will carry out a series of direct simulations of the model, by withdrawing these shocks one after another. So, we will be able to identify the effect of each shock on the consumption deflator, the price of the tradable good and the internal term of trade in Ireland. Let us start by examining this last variable. The last line of Table 13 gives the observed evolution of the internal term of trade from 1996 to 2002. It increased steadily over the period. The second line gives the reference value of the term of trade when all the shocks

have been withdrawn from the economy. The other lines give the contributions of the most significant shocks, expressed in percentage points of the term of trade. The line total sums the effects of all the shocks that they appear or not in the table. We can make the following comments.

PUT TABLE 13 HERE

1. The initial values of the three prices differed from their reference steady state values. We estimate that the parity of the Irish pound compared to the euro was too low in 1996 and contributed to an undervaluation of the internal term of trade by 2.08%. This margin was reduced in the course of time and was equal to nothing more than 0.15% in 2002. This adjustment gives a first explanation of the decrease in the internal term of trade.

2. As was noted before, the evolution of the relative productivities in the two sectors contributed to an increase in the internal term of trade. Wage moderation contributed to decrease the internal term of trade, but at an extent which weakened over time.

3. The rise in labour supply reduced the shortage of labour in the non-tradable sector, which slowed down the rise in the internal term of trade.

4. The lines balance of payments and autonomous demands must be commented on together for the reasons given above. Their evolutions contributed to slow down the increase in the term of trade over 1996-2002.

5. The diffusion of the shocks hitting the economies of the other European countries towards Ireland contributed to a steady increase in the internal term of trade.

6. The increasing preference for non-tradable goods by Irish households contributed to a steady increase in the internal term of trade. This change of taste was connected to the boom in the housing sector. However, its effect on the term of trade was rather weak, and for this reason this factor does not appear in the table.

Now to examine the price of the tradable good, we will look at Table 14.

PUT TABLE 14 HERE

The price of the tradable good dropped steadily over the investigated period. The shocks on the other European countries, and to a lesser extent on the rest of the world, were the main causes of this fall. It was slowed down by the relatively expansionary policy of the ECB.

As in the case of Germany, the examination of the fall of the consumption deflator can easily be understood by looking at equation (1'). The deflator of the household consumption increased over the period, but presented a flat over 1997-1999. The price of the tradable good decreased over the period and the internal term of trade increased for the reasons which we have just given. The rate of indirect taxation strongly increased from 1996 to 2000 and dropped slightly in 2001. We also noted that the Irishmen consumed goods the average price of which increased faster than the average price of the goods which are produced nationally, and than the relative quality of the Irish tradable good hardly changed over the period.

The IMF (2003) carried out a decomposition of the inflation gap between Ireland and the Euro area, similar to the one we did. The Balassa-Samuelson effect, that is the strong increase in the productivity of the tradable sector, explained half of this gap. The increase in indirect taxation played a significant role for some years. The fall in the real interest rate resulting from joining the EMU played a role: Fitz Gerald (2001) commented on the fall of the risk premium on the interest rate, which Ireland benefited then (in our evaluations it only affected the price of the tradable good). The rise in households' consumption nourished by the capital gains on housing contributed to inflation (this effect is non-existent in our evaluation). The expansionary tax policy of years 2000-2002 played a role (it played none in our evaluation). The increase in foreign direct investments, encouraged by the belonging to the EMU, and the imported inflation from the United States resulting from the depreciation of the euro relative to the dollar, also contributed to inflation (we find that the evolution of the autonomous demand slowed down inflation until 2000 but increased afterwards, and that the shock hitting the balance of payments slowed down inflation). A possible reason for the divergence between the results obtained by the IMF and ours is that the IMF used partial equilibrium analysis

whereas we resorted to a general equilibrium model. The similarities of the results are however many, especially as for the role of the Balassa-Samuelson effect.

Finally we looked at the diffusion of the shocks hitting the Irish economy to the exchange rate of the euro, the interest rate in Europe and the economic situation in France. Irish shocks led to some light depreciation of the euro, but had little effect on the French economy.

Conclusion

The paper has shown that inflation gaps between countries of the Euro area can be large (a few per cent per year) and persistent, and this for quite natural and healthy causes. We have focused our presentation on the cases of Germany and Ireland, but we investigated also the other countries. The Balassa-Samuelson effect was present in many European countries and contributed to the increase of their internal terms of trade. However, its strength differed across countries (it was less powerful in France than in Ireland for instance), and it worked in an inverted way in Germany. Households bought goods the average prices of which increased faster than the average prices of domestically produced goods. Their preference for non tradable goods increased over time. However, the intensity of these effects differed across countries. The initial parities with the euro of the former European currencies also played a role in the explanation of the inflation gaps (the mark was overvalued and the Irish pound and the French franc were undervalued). The quality of the tradable good increased at different speed across countries (it increased faster in Germany, Greece and Spain than in France). Changes in indirect taxation, in the behaviour of trade unions, in the rate of activity and the inflow of migrants also played a role.

Appendix: The model

The model includes 11 European countries indexed by j and the rest of the world identified by a *. Their respective currencies are the euro and the dollar.

Equations

- *Law of one price for tradable goods*

$$pt_i / q_i = pt_j / q_j \tag{a1}$$

- *Production functions and demand of labour in both sectors*

$$QT_j = AT_j LT_j^{at_j} \tag{a2}$$

$$at_j QT_j / LT_j = wt_j / pt_j \tag{a3}$$

$$QN_j = AN_j LN_j^{an_j} \tag{a4}$$

$$an_j QN_j / LN_j = wn_j / pn_j \tag{a5}$$

- *Wages equations in both sectors.* The real cost of labour is sensitive to the wedge between this cost and the real after- tax wage rate

$$\begin{aligned}\ln(wt_j) = {} & \ln\left(\frac{QT_j + QN_j}{LT_j + LN_j}\right) + j_{0j} + j_1\left[(1-j_n)\ln(pt_j) + j_n \ln(pc_j) + j_n \ln(1+tw_j)\right] \\ & + (1-j_1)\left[(1-j_j)\ln(pt_{j,-1}) + j_j \ln(pc_{j,-1}) + j_j \ln(1+tw_{j,-1})\right] + j_2 \ln\left(\frac{LT_j + LN_j}{N_j}\right)\end{aligned} \tag{a6}$$

$$\begin{aligned}\ln(wn_j) = {} & \ln\left(\frac{QT_j + QN_j}{LT_j + LN_j}\right) + j'_{0j} + j_1\left[(1-j_n)\ln(pn_j) + j_j \ln(pc_j) + j_n \ln(tw_j)\right] \\ & + (1-j_1)\left[(1-j_n)\ln(pn_{j,-1}) + j_j \ln(pc_{j,-1}) + j_j \ln(tw_{j,-1})\right] + j_2 \ln\left(\frac{LT_j + LN_j}{N_j}\right)\end{aligned} \tag{a7}$$

- *Consumption spending of credit constrained and credit unconstrained households.* 'Keynesian' households receive a proportion x_j of after tax labour income minus lump sum taxes net of transfers, and wholly spend it on current consumption. 'Neoclassical' households optimise intertemporally. Their behaviour is summed up by the Euler's equation (a9)

$$pc_j CK_j = x_j[(1-tw_j)(wn_j LN_j + wt_j LT_j) - (T_j + u_j B_{j,-1})] \quad \text{(a8)}$$

$$\left(\frac{CNC_{j,+1}}{CNC_j}\right)^r = \left(\frac{1+i_j}{1+b_j}\right)\frac{pc_j}{pc_{j,+1}} \quad \text{(a9)}$$

$$C_j = CNC_j + CK_j \quad \text{(a10)}$$

- *Housholds' consumption, Government's consumption and national demand of both goods.* The current utility of households and the Government is a Cobb Douglas function of their consumptions of each good. Equations (a11) to (a14) give the optimal allocation of their consumption spending between the two goods. Equation (a15) defines the associated price consumption index.

$$pt_j \frac{1+tc_j}{1+t\bar{c}_{Ge,1995}} CT_j = b_j pc_j C_j \quad \text{(a11)}$$

$$pn_j \frac{1+tc_j}{1+t\bar{c}_{Ge,1995}} CN_j = (1-b_j) pc_j C_j \quad \text{(a12)}$$

$$pt_j \frac{1+tc_j}{1+t\bar{c}_{AGe,1995}} GGT_j = b_j pc_j GG_j \quad \text{(a13)}$$

$$pn_j \frac{1+tc_j}{1+t\bar{c}_{Ge,1995}} GGN_j = (1-b_j) pc_j GG_j \quad \text{(a14)}$$

$$\ln(pc_j) = \ln\left(\frac{1+tc_j}{1+t\bar{c}_{Ge,1995}}\right) + a_j + b_j \ln(pt_j / q_j) + (1-b_j)\ln(pn_j) \quad \text{(a15)}$$

$$DT_j = GGT_j + CT_j + AGT_j \quad \text{(a16)}$$

$$DN_j = GGN_j + CN_j + AGN_j \tag{a17}$$

Equilibrium on the non tradable good market. The stickiness of the price of this good creates a short run disequilibrium between demand and effective production on one hand and potential production on the other hand

$$\ln(DN_j / QN_j) = \frac{1}{l}\ln\left[\frac{pn_j}{pn_{j,-1}(1+\bar{p})}\right] \tag{a18}$$

Equilibrium on the tradable good market. The surplus of the effective output of this good on the national demand for it is equal to the surplus of the trade balance, and finances foreign interest payments and the reduction of foreign debt. The stickiness of the price of this good creates short run disequilibrium between its effective and potential productions. The tradable good produced by the rest of the world is an imperfect substitute to European tradable goods. Equation (a21) gives the demand for this good. Equation (a22) is the world equilibrium of the market of tradable goods.

$$pt_j\left(QET_j - DT_j\right) - i^* eF_{j,-1} = -e\left(F_j - F_{j,-1}\right) + (1+g)^t (1+\bar{p})^t ec_j \tag{a19}$$

$$\ln(QET_j / QT_j) = \frac{1}{l}\ln\left[\frac{pt_j}{pt_{j,-1}(1+\bar{p})}\right] \tag{a20}$$

$$(ept^* / q^*)/(pt_j / q_j) - 1 = y\,(D^* - \bar{D}^*)/(1+g)^t - DM \tag{a21}$$

$$\sum_{j=1}^{11} q_j (QET_j - DT_j) = q^* D^* \tag{a22}$$

Monetary policy of the European Central Bank. Equation (a23) defines the average inflation rate in the Euro area. Equation (a24) is the monetary reaction function of the ECB

$$p = \frac{\sum_{j=1}^{11} \bar{C}_j (pc_j / pc_{j,-1} - 1)}{\sum_{j=1}^{11} \bar{C}_j} \tag{a23}$$

$$1+i=(1+\bar{r})(1+\bar{p})+1.5\ (p-\bar{p})+bce \qquad \text{(a24)}$$

Uncovered interest rate parity. The interest rate in each country is related to the interest rate in the rest of the world by an uncovered interest rate equation including a risk premium. This premium depends on the foreign indebtedness of the country. Equation (a26) defines the average rate of interest in Europe. Equation (a27) gives the world equilibrium of the foreign debt market.

$$\left(1+i_j-m_j\frac{\bar{e}F_{j,-1}}{\bar{p}\bar{t}_j\bar{Q}\bar{T}_j}\right)e/e_{+1}=1+i^*+pr \qquad \text{(a25)}$$

$$i=\frac{\sum_{i=1}^{11}\bar{p}\bar{t}_i\bar{Q}\bar{T}_i i_i}{\sum_{i=1}^{11}\bar{p}\bar{t}_i\bar{Q}\bar{T}_i} \qquad \text{(a26)}$$

$$\sum_{j=1}^{11}F_j+F^*=0 \qquad \text{(a27)}$$

Government budget balance. Taxes are set on labour income, profit and households' consumption. There also exist lump sum taxes net of transfers. The Government consumes tradable and non tradable goods. Finally, public debt is stabilised by a lump sum tax proportional to the amount of debt.

$$\begin{aligned} pc_jGG_j=&\frac{tw_j}{1+tw_j}(wn_jLN_j+wt_jLT_j)+tp_j(pn_jDN_j+pt_jQET_j-wn_jLN_j-wt_jLT_j)\\ &+\frac{tc_j}{1+tc_j}pc_jC_j+(T_j+n_jB_{j,-1})-iB_{j,-1}+(B_j-B_{j,-1}) \end{aligned} \qquad \text{(a28)}$$

Endogenous variables

B_j Public debt in euros in country j

C_j Total households' consumption in country j

CK_j Consumption by 'Keynesian' households in country j

CNC_j Consumption by neoclassical households in country j

CN_j Consumption in non tradable good by the households of country j

CT_j Consumption in tradable good by the households of country j

D^* Net demand of tradable good by the rest of the world

DN_j Total demand and effective output in tradable good by country j

DT_j Total demand in tradable good by country j

e Exchange rate of the euro against the dollar

F_j Foreign debt in dollars of country j

F^* Foreign debt in dollars of the rest of the world

GGT_j Consumption in tradable good by the Government of country j

GGN_j Consumption in non tradable good by the Government of country j

i European nominal interest rate

i_j Nominal interest rate in country j

LN_j Employment in the non tradable sector of country j

LT_j Employment in the tradable sector of country j

pc_j Consumption deflator in country j

pn_j Added value price of the non tradable good in country j

pt_j Added value price of the tradable good in country j

p Average inflation rate in Europe

QN_j Potential added value of the non tradable sector in country j

QET_j Effective added value of the tradable sector in country j

QT_j Potential added value of the tradable sector in country j

wt_j Nominal cost of labour in the tradable sector of country j

wn_j Nominal cost of labour in the non tradable sector of country j

The model includes 247 equations and as many endogenous variables.

Exogenous variables

a_j Slack variable in the definition of the consumption deflator

AGN_j Other autonomous demand in non tradable good by country j

AGT_j Other autonomous demand in tradable good by country j

AN_j Global productivity of the non tradable sector in country j

AT_j Global productivity of the tradable sector in country j

an_j Labour cost share in the value added of the tradable sector of country j

at_j Labour cost share in the value added of the non tradable sector of country j

b_j Consumption share allocated to the tradable good in country j

bce Slack variable in the reaction function of the ECB

b_j Households' discount rate in country j

$\overline{C}_j$ Households' consumption in country j on the reference steady state

$\overline{D}^*$ Net demand of tradable good by the rest of the world on the reference steady state

DM Slack variable in the demand of European tradable good by the rest of the world

ec_j Slack variable in the balance of payments identity of country j

jn_{0j} Bargaining power of trade unions in the non tradable sector of country j

jt_{0j} Bargaining power of trade unions in the tradable sector of country j

GG_j Government's consumption in country j

$i*$ Nominal interest rate in the rest of the world

x_j Proportion of households constrained on the credit market in country j

N_j Active population in country j

n_j Sensitivity of Government's transfers to public debt

pr Fixed risk premium on the euro

$pt*$ Price of the tradable good in the rest of the world

$\bar{pt}_j$ Price of the tradable good in country j on the reference steady state

$\bar{p}$ Inflation target of the ECB (equal to the inflation rate in the steady state)

$q*$ Quality of the tradable good produced by the rest of the world

q_j Quality of the tradable good produced by country j

$\bar{QT}_j$ Added value of tradable good in country j on the reference steady state

$\bar{r}$ Real interest rate target of the ECB equal to the real interest rate on the reference steady state

T_j Exogenous part of lump sum taxes net of transfers in country j

tc_j Taxation rate of households' consumption in country j

tp_j Taxation rate of firms' profit in country j

tw_j Taxation rate of net wages in country j

Reference steady state and calibration

The equations of the model are consistent with balanced growth paths, such that each variable grows at a constant rate over time. These rates depend on exogenous variables (such as the natural growth rate of the European economy) and on the inflation target of the ECB (which will be assumed constant in the long run). Then, we can rewrite the model in reduced variables that is in variables detrended by their balanced growth rates. When the values of the exogenous variables are set at constant levels, the

model has a well-defined steady state[13]. Moreover, the model is autonomous relative to time, that is time does not appear directly in the equations.

The model was calibrated in a way such that its reference steady state reproduces the average situation of European countries over the period 1995-2001. So, we started by building a data bank for European countries over a period including this span of time, by using mainly data from the annual national accounts of the OECD. The wages equations were estimated on the panel of the 11 countries (assuming that only the constant term differed between countries). Other parameters were set to values that can be found in economic literature.

Simulation of the model

The model includes variables appearing with a lead. A local condition of existence and uniqueness of a solution in the neighbourhood of the reference steady state is that the number of eigenvalues with modulus larger than one is equal to the number of non redundant variables with a lead. We found both numbers to be equal to the number of countries plus one (that is to 12) and the local condition was satisfied. The hysteresis property of the model resulting from the inflation rule followed by the ECB, induces an eigenvalue equal to 1. The computation of eigenvalues, and the direct and inverted simulations of the model were made under the freeware Dynare, developed by Juillard (2004).

Acknowledgements

I thank Pierre Beynet, Benjamin Carton and Jean-Luc Schneider for the stimulating discussions we had on previous versions of this paper. A preliminary version of the paper was presented in a seminar at the University of Louvain-la-Neuve and benefited from very useful comments. We are grateful to the *Direction de la Prévision*, which financed this research.

References

Canzoneri, M., Cumby, R., Diba, B., 1999 Relative labor productivity and the real exchange rate in the long run: Evidence for a panel of OECD countries, Journal of International Economics 47, 245-266.

Canzoneri, M., Cumby, R., Diba, B., Eudey, G., 2001, "Productivity trends in Europe: Implications for real exchange rates, real interest rates and inflation", mimeographed Georgetown University, May.

Cechetti, S.G., Mark, N.C., Sonora, R.J., 2002, Price index convergence among United states cities, International Economic Review 43, 1081-1099.

Cechetti, S.G., Wynne, M.A., 2003, Inflation measurement and the ECB's pursuit of price stability: a first assessment, Economic Policy 37, 397-434.

Freeman, A., 2001, Work in progress. A survey of European business and the Euro, The Economist, 1 December 2001.

Fitz Gerald, J., 2001, Managing an economy under EMU: The case of Ireland, The World Economy 24(10), 1353-1371.

Heston, A., Summers, R., Atten, B., Nuxoll, D.A., 1995, New kinds of comparisons of the prices of tradables and nontradables, CICUP, 95-3.

Honohan, P., Walsh, B., 2002, Catching up with the leaders: The Irish hare, Brookings Papers on Economic Activity 1, 1-77.

Honohan, P., Lane, P.R., 2003, Divergent inflation rates in EMU, Economic Policy 37, 359-394.

International Monetary Fund, 2003, Ireland, Staff Report for the 2003 Article IV Consultation, 9 July.

Juillard, M., 2004, Dynare home page, http://www.cepremap.cnrs.fr/juillard/dynare/index.html.

O.E.C.D., 1993, Parité des pouvoirs d'achat et dépenses réelles. 1990 , Volume 2, Résultats GK, OECD.

Rogers, J.H., 2001, Price level convergence, relative prices, and inflation in Europe, International Finance Discussion Paper n° 699, Board of Governors of the Federal Reserve System.

Rogers, J.H., 2002, Monetary union, price level convergence, and inflation: How close is Europe to the United States?, International Finance Discussion Paper n° 740, Board of Governors of the Federal Reserve System.

Table 1: Comparable consumption deflators

Price	1996	1997	1998	1999	2000	2001	2002
Germany	1.072	1.075	1.067	1.051	1.047	1.045	1.040
Austria	1.045	1.042	1.029	1.019	1.017	1.019	1.019
Belgium	0.943	0.939	0.933	0.928	0.932	0.938	0.928
Spain	0.767	0.771	0.770	0.773	0.783	0.795	0.809
Finland	1.124	1.147	1.133	1.124	1.144	1.163	1.178
France	0.971	0.977	0.970	0.957	0.954	0.953	0.954
Greece	0.744	0.784	0.754	0.764	0.749	0.749	0.762
Ireland	0.853	0.940	0.915	0.918	0.940	0.962	1.007
Italy	0.801	0.840	0.839	0.839	0.848	0.856	0.866
Netherlands	0.926	0.924	0.921	0.922	0.935	0.962	0.975
Portugal	0.584	0.599	0.597	0.598	0.608	0.618	0.629
Average	0.894	0.912	0.903	0.899	0.905	0.915	0.924
Standard deviation	0.162	0.156	0.154	0.149	0.150	0.151	0.151

Table 2: Rates of inflation of consumption deflators

Inflation % per year	1996	1997	1998	1999	2000	2001	2002
Germany	-0.13	0.23	-0.72	-1.52	-0.32	-0.25	-0.45
Austria	0.16	-0.31	-1.21	-0.92	-0.27	0.21	0.05
Belgium	0.35	-0.38	-0.73	-0.52	0.49	0.67	-1.11
Spain	5.13	0.52	-0.15	0.38	1.34	1.47	1.82
Finland	-0.29	2.07	-1.24	-0.72	1.77	1.67	1.26
France	2.53	0.62	-0.69	-1.39	-0.28	-0.15	0.18
Greece	7.44	5.34	-3.77	1.25	-1.93	0.05	1.70
Ireland	5.68	10.29	-2.71	0.36	2.41	2.31	4.65
Italy	13.70	4.84	-0.11	0.02	1.11	0.88	1.17
Netherlands	0.08	-0.25	-0.25	0.03	1.47	2.88	1.32
Portugal	4.69	2.55	-0.24	0.14	1.61	1.66	1.74
Average	3.58	2.32	-1.07	-0.26	0.67	1.04	1.12
Standard deviation	4.35	3.32	1.16	0.83	1.26	1.04	1.52

Table 3: Comparable prices of the tradable good

Tradable good price	1996	1997	1998	1999	2000	2001	2002	Relative change % 1996-2001
Germany	1.080	1.058	1.056	1.044	1.012	1.020	1.010	-5.572
Austria	1.006	0.981	0.965	0.945	0.936	0.929	0.921	-7.621
Belgium	1.009	0.974	0.952	0.919	0.907	0.892	0.875	-11.592
Spain	0.853	0.838	0.814	0.793	0.791	0.802	0.820	-5.983
Finland	1.011	1.007	1.025	0.955	0.958	0.934	0.895	-7.654
France	1.003	0.997	0.981	0.943	0.922	0.926	NA	-7.746
Greece	0.808	0.826	0.788	0.773	0.756	0.770	0.778	-4.682
Ireland	0.927	0.963	0.894	0.855	0.841	0.857	NA	-7.573
Italy	0.876	0.900	0.898	0.877	0.875	0.891	0.885	1.790
Netherlands	0.960	0.962	0.939	0.901	0.935	0.957	0.942	-0.285
Portugal	0.853	0.846	0.839	0.828	0.833	0.870	0.873	2.035
Average	0.944	0.941	0.923	0.894	0.888	0.895	NA	-4.989
Standard deviation	0.087	0.077	0.085	0.079	0.077	0.070	NA	

Table 4: Comparable prices of the non-tradable goods

Non-tradable good price	1996	1997	1998	1999	2000	2001	2002	Relative change % 1996-2001
Germany	1.054	1.039	1.017	0.985	0.952	0.932	0.929	-11.538
Austria	0.971	0.961	0.947	0.932	0.934	0.939	0.932	-3.241
Belgium	0.884	0.876	0.886	0.892	0.889	0.892	0.894	0.917
Spain	0.710	0.718	0.723	0.733	0.751	0.775	0.795	9.045
Finland	0.938	0.972	0.968	0.953	0.976	1.006	1.004	7.165
France	0.863	0.877	0.873	0.869	0.871	0.869	NA	0.679
Greece	0.621	0.659	0.633	0.643	0.626	0.624	0.634	0.590
Ireland	0.777	0.790	0.786	0.783	0.785	0.783	NA	0.679
Italy	0.706	0.736	0.736	0.734	0.732	0.740	0.751	4.799
Netherlands	0.876	0.866	0.869	0.870	0.882	0.904	0.927	3.123
Portugal	0.428	0.446	0.442	0.436	0.439	0.438	0.443	2.409
Average	0.803	0.813	0.807	0.803	0.803	0.809	NA	1.330
Standard deviation	0.178	0.168	0.167	0.161	0.161	0.164	NA	

Table 5: Germany. Non-observable exogenous variables

	1996	1997	1998	1999	2000	2001	2002
tc_Ge	0.218	0.214	0.217	0.228	0.225	0.217	
a_Ge	0.041	0.057	0.067	0.078	0.106	0.121	0.119
q_Ge	1.077	1.061	1.076	1.107	1.097	1.102	1.091
jt_0_Ge	-0.444	-0.462	-0.470	-0.503	-0.499	-0.453	-0.439
jn_0_Ge	-0.653	-0.690	-0.699	-0.725	-0.741	-0.678	-0.668
AT_Ge	0.0795	0.0986	0.0890	0.0902	0.0987	0.0742	0.0837
AN_Ge	0.2468	0.2453	0.2562	0.2715	0.2674	0.2457	0.2203
an_Al	0.496	0.485	0.475	0.481	0.497	0.514	0.518
at_Al	0.721	0.743	0.732	0.715	0.786	0.744	0.762
b_Ge	0.405	0.399	0.398	0.395	0.387	0.393	0.392

Table 6: Germany. Observable exogenous variables

	1996	1997	1998	1999	2000	2001	2002
N_Ge	30.107	30.385	30.510	30.539	30.805	30.928	30.859
tw_Ge	0.616	0.591	0.577	0.589	0.602	0.547	0.535
GGT_Ge	0.092	0.089	0.085	0.083	0.082	0.082	0.080
GGN_Ge	0.138	0.136	0.134	0.135	0.138	0.138	0.136
AGT_Ge	-0.062	-0.064	-0.057	-0.054	-0.039	-0.086	-0.085
AGN_Ge	0.188	0.181	0.183	0.184	0.171	0.164	0.142
-T_Ge	0.397	0.358	0.338	0.336	0.290	0.331	0.327

Table 7: Europe. Non-observable and observable variables

	1996	1997	1998	1999	2000	2001	2002
ecb	-5.5	-1.9	1.0	0.2	0.1	-0.1	-1.3
pr	-12.9	-1.0	-4.3	-15.0	-2.4	4.3	-0.4
e	0.7694	0.8866	0.8997	0.9386	1.0854	1.1175	1.0626
$\Delta e / e_{-1}$	5.01	15.23	1.48	4.32	15.64	2.96	-4.91
pi	6.26	3.41	1.17	1.13	2.17	2.33	2.37
i	4.92	4.25	3.83	2.97	4.39	4.26	3.32

Table 8: Germany. Decomposition of the internal term of trade between elementary shocks

pn_Ge/pt_Ge	1996	1997	1998	1999	2000	2001	2002
Reference	0.949	0.949	0.949	0.949	0.949	0.949	0.949
Initial prices	5.38	3.53	2.29	1.47	0.91	0.54	0.29
Balance of payments	-1.02	-1.72	-2.18	-2.48	-2.68	-2.81	-2.90
Productivity	-2.27	-2.12	-3.30	-5.41	-6.24	-7.64	-6.55
Autonomous demand	1.36	2.18	2.66	3.01	2.66	2.86	3.60
Labour market	0.47	1.03	1.77	3.00	4.04	4.34	3.82
Quality	1.22	1.93	0.48	-2.31	-3.04	-3.03	-2.23
Rest of the world	-0.87	-1.80	-2.27	-1.88	-1.03	-1.23	-2.14
Other European countries	-1.81	-1.00	0.11	2.45	3.12	2.75	2.90
Total	0.977	0.983	0.965	0.947	0.945	0.919	0.924
Observed	0.975	0.982	0.964	0.944	0.940	0.914	0.919

Table 9: Germany. Decomposition of the price of the tradable good between elementary shocks

pt_Ge	1996	1997	1998	1999	2000	2001	2002
Reference	1.040	1.040	1.040	1.040	1.040	1.040	1.040
Initial prices	0.70	0.97	1.12	1.20	1.23	1.24	1.23
Balance of payments	0.26	0.42	0.54	0.62	0.69	0.75	0.81
Households	0.25	0.26	0.13	-0.06	-0.21	-0.60	-1.10
Productivity	0.19	-0.06	0.48	1.48	1.63	2.14	2.01
Autonomous demand	-0.04	-0.02	0.20	0.48	1.04	0.80	-0.20
Labour market	-0.22	-0.59	-1.15	-2.18	-3.05	-3.30	-3.23
Quality	-0.27	-1.28	-0.16	1.86	1.20	1.47	0.72
a_Al	-0.23	-0.98	-1.50	-1.89	-2.14	-1.98	-1.73
ECB	2.32	2.73	2.53	2.78	3.17	3.63	4.04
Rest of the world	0.64	1.51	2.07	1.81	1.03	1.26	2.28
Other European countries	-0.30	-2.06	-3.70	-6.65	-8.11	-8.30	-8.81
Total	1.080	1.059	1.057	1.047	1.017	1.025	1.016
Observed	1.080	1.058	1.056	1.044	1.012	1.020	1.010

Table 10: Diffusion of the shocks hitting the German economy toward Europe and France

	Reference	1996	1997	1998	1999	2000	2001	2002
e	0.966	2.83	3.29	3.66	3.62	3.29	3.43	3.27
i	5.74	0.47	0.38	-0.01	-0.34	0.16	-0.17	-0.74
pc_Fr	0.962	0.64	0.71	0.71	0.46	0.36	0.33	-0.01
pt_Fr	0.962	1.59	1.50	1.15	0.31	0.04	-0.08	-0.93
pn_Fr	0.870	0.84	0.25	0.44	0.56	0.55	0.58	0.55
LT_Fr	5040	45.389	25.473	11.903	-12.322	-12.976	-14.310	-37.927
LN_Fr	10453	-15.055	-9.851	-5.539	3.900	5.872	7.161	15.789
CT_Fr	286	-1.50	-0.93	-0.16	0.72	0.60	0.89	1.72
CN_FR	532	0.03	0.35	0.56	0.45	0.07	0.21	0.17

Table 11: Ireland. Non-observable exogenous variables

	1996	1997	1998	1999	2000	2001	2002
tc_Ir	0.230	0.263	0.286	0.307	0.325	0.298	
a_Ir	-0.039	0.026	-0.004	0.007	0.025	0.069	0.115
q_Ir	0.924	0.965	0.911	0.907	0.911	0.926	0.926
jt_0_Ir	-0.492	-0.568	-0.754	-0.744	-0.709	-0.672	-0.685
jn_0_Ir	-0.363	-0.406	-0.640	-0.637	-0.617	-0.538	-0.544
AT_Ir	0.0350	0.0391	0.0519	0.0544	0.0564	0.0541	0.0562
AN_Ir	0.0374	0.0397	0.0417	0.0426	0.0434	0.0437	0.0431
an_Ir	0.768	0.798	0.753	0.773	0.802	0.842	0.871
at_Ir	0.541	0.484	0.348	0.350	0.355	0.371	0.345
b_Ir	0.490	0.495	0.475	0.462	0.467	0.460	0.460

Table 12: Ireland. Observable exogenous variables

	1996	1997	1998	1999	2000	2001	2002
N_Ir	1.148	1.1949	1.2836	1.3242	1.3621	1.3896	1.3964
tw_Ir	0.440	0.484	0.474	0.503	0.500	0.443	0.390
GGT_Ir	0.0033	0.0034	0.0035	0.0039	0.0044	0.0050	0.0054
GGN_Ir	0.0041	0.0042	0.0044	0.0050	0.0054	0.0064	0.0070
AGT_Ir	-0.0032	-0.0013	0.0017	0.0009	0.0013	-0.0008	-0.0074
AGN_Ir	0.0015	0.0034	0.0061	0.0069	0.0086	0.0076	0.0070
-T_Ir	0.0062	0.0071	0.0079	0.0103	0.0094	0.0113	NA

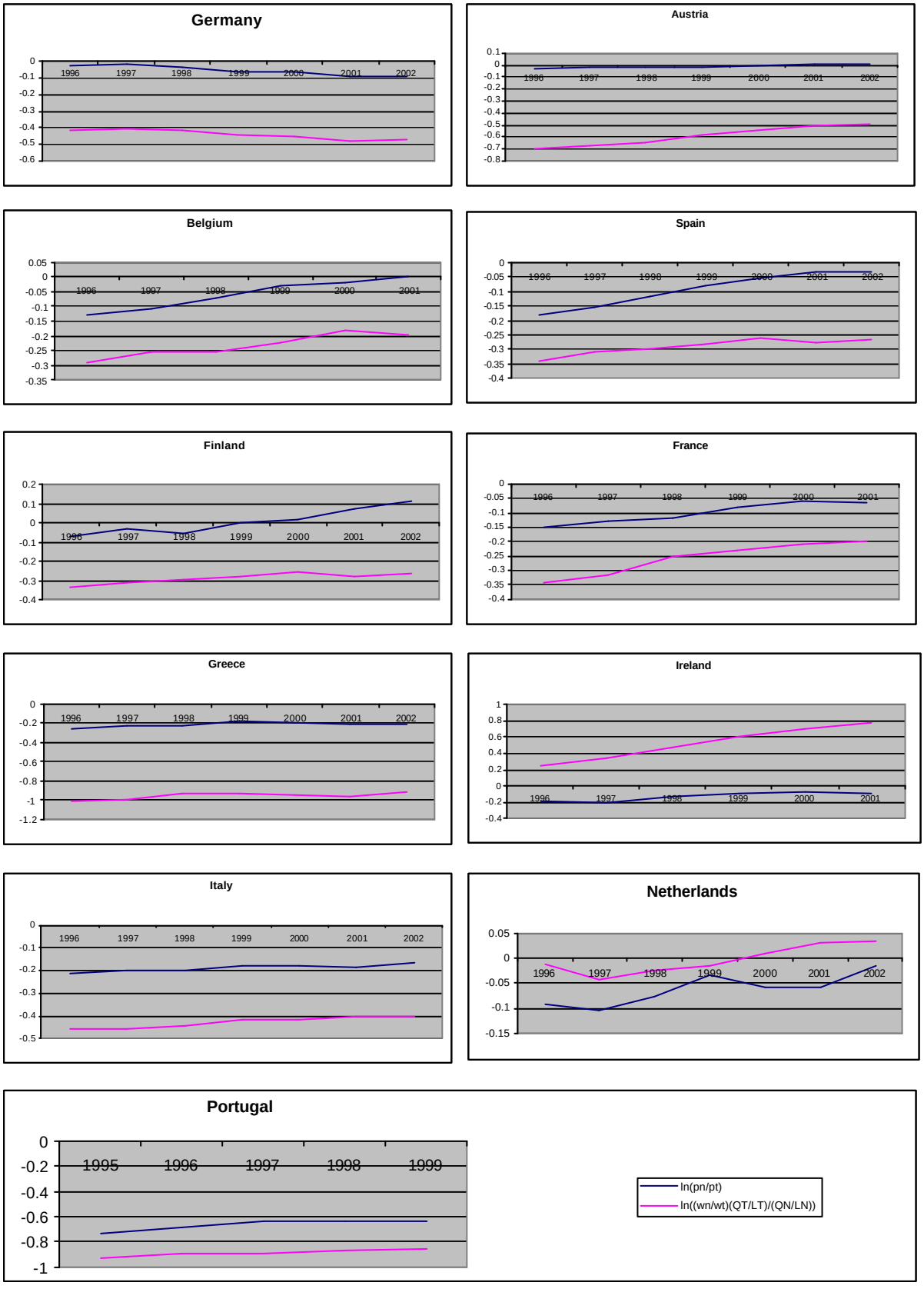
Table 13: Ireland. Decomposition of the internal term of trade between elementary shocks

pn_Ir/pt_Ir	1996	1997	1998	1999	2000	2001	2002
Reference	0.881	0.881	0.881	0.881	0.881	0.881	0.881
Initial prices	-2.08	-1.45	-1.00	-0.67	-0.44	-0.27	-0.15
Labour supply	5.03	7.02	5.54	3.31	0.74	-1.72	-3.57
Balance of payments	-6.21	-10.45	-13.45	-15.64	-17.26	-18.45	-19.31
Net transfers by the Government	-0.13	0.25	0.94	2.63	3.42	4.91	6.01
Productivity	-4.27	-8.03	7.54	20.23	28.29	22.53	19.83
Autonomous demand	48.88	59.49	40.63	26.39	19.33	23.70	27.57
Labour market	-25.45	-23.96	-23.18	-21.71	-20.15	-19.04	-20.14
Quality	-4.12	1.47	1.86	1.35	-0.18	-0.17	-2.23
Rest of the world	-0.85	-1.69	-2.08	-1.63	-0.71	-0.86	-1.62
Other European countries	-3.88	-3.17	-1.68	1.38	2.11	1.80	NA
Total	0.957	0.974	0.979	0.995	1.013	0.991	NA
Observed	0.838	0.821	0.880	0.915	0.933	0.913	NA

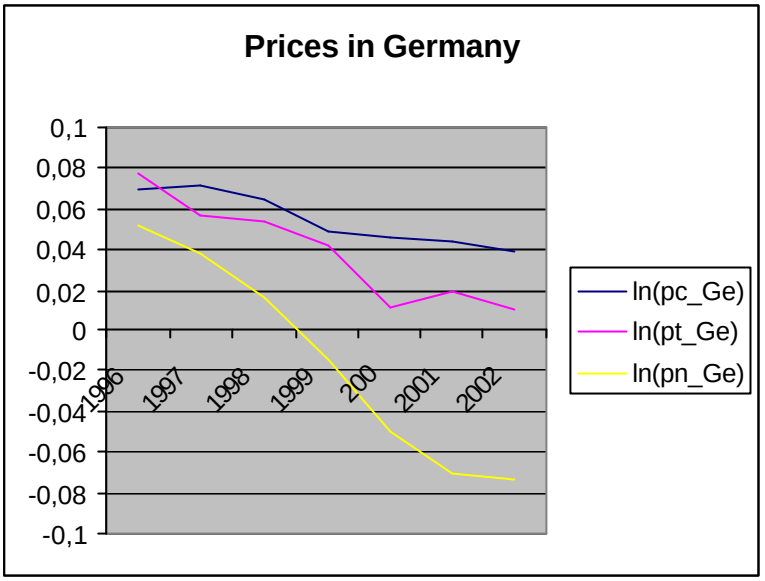
Table 14: Ireland. Decomposition of the price of the tradable good between elementary shocks

pt_Ir	1996	1997	1998	1999	2000	2001	2002
Reference	0.889	0.889	0.889	0.889	0.889	0.889	0.889
Initial prices	-0.08	-0.08	-0.07	-0.07	-0.07	-0.07	-0.07
Balance of payments	0.09	0.16	0.23	0.28	0.34	0.40	0.46
Autonomous demand	-0.18	-0.29	-0.36	-0.44	-0.51	-0.59	-0.76
Quality	-0.05	4.38	-1.43	-1.85	-1.38	0.14	0.14
ECB	2.32	2.73	2.56	2.84	3.27	3.79	4.27
Rest of the world	0.67	1.53	2.10	1.84	1.03	1.23	2.22
Other European countries	1.27	-0.51	-2.51	-6.18	-7.77	-8.02	NA
Total	0.927	0.961	0.894	0.857	0.843	0.860	NA
Observed	0.927	0.963	0.894	0.855	0.841	0.857	NA

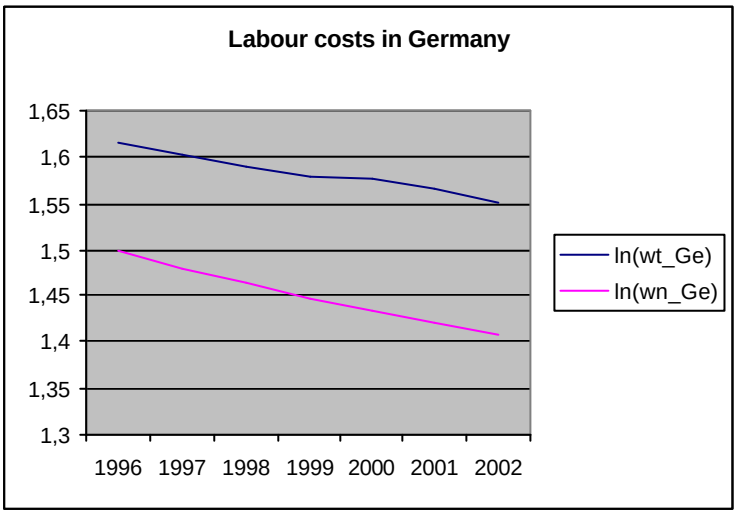
Graphs 1: Internal terms of trade and ratios of the unit costs of labour in the two sectors



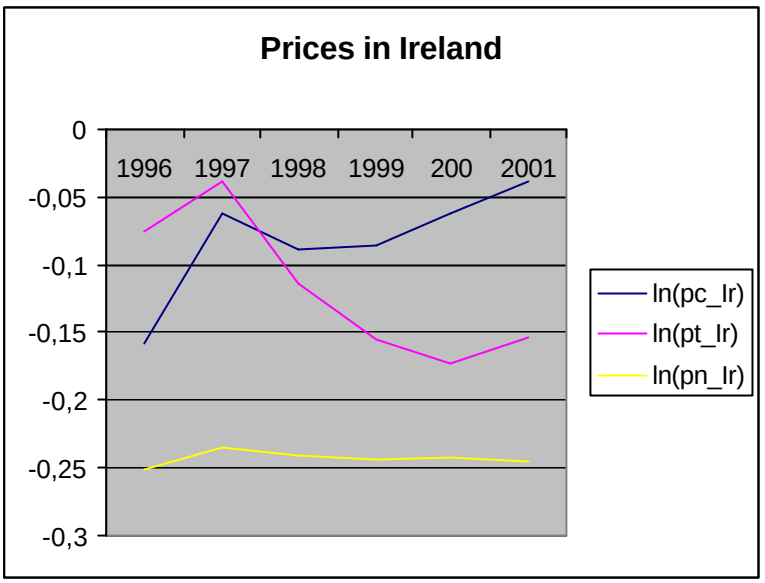
Graph 2: Prices in Germany



Graph 3: Labour costs in Germany



Graph 4: Prices in Ireland



Graph 5: Labour costs in Ireland

Footnotes

[1] The discussions on inflation in the Euro area and on the target of the European Central Bank, relate to harmonised indices, which have the advantage of being published monthly. We prefer to retain here the households' consumption deflator of the national accounts of the OECD, because of its consistency with the other data we use in the model developed for this paper. The evolution of the deflator is approximately the same as that of the harmonised index (Cechetti and Wynne(2003)).

[2] The tradable sector includes agriculture-hunting and foresting+fishing, plus industry including energy. The non tradable sector includes construction, wholesale and retail trade+repairs+hotels and restaurants+transport, financial intermediation+real estate+renting and business activities.

[3] The price indices we need are easily computed out of the national accounts of the OECD. However, these indices are all equal to 1 in 1995 and that in each country. So, they allow comparing prices at different times in the same country, but they do not allow a comparison between countries and that for two reasons. First, before the introduction of the euro, the intra-European exchange rates could change. So, we decided to measure all prices in Europe in a common currency. Then, prices differed between European countries in 1995. Thus, we used an evaluation by the OECD (1993) of the prices of the non-tradable and tradable goods and of households' consumption, comparable between European countries, for the year 1990, and we adjusted our series to these values. Finally, as the starting point of each of the price series we took Germany in 1995, to which we allotted the value 1. We thus obtained series of prices comparable over time and between European countries.

[4] Honohan and Lane (2003) noted that over the 1999-2001 period the coefficient of variation of the inflation rates of the American States was hardly lower than that of the European countries. Cechetti et al. (2002) noticed a positive relation between the dispersion of relative consumption prices between American cities in a given year, and the persistence of these prices over time. This persistence, analysed over the period 1918-1995, was however insufficient to prevent relative prices from being stationary. The speed of convergence of the relative price between two cities increased with the

proximity of these cities. It was also faster for the prices of tradable goods than for those of non-tradable goods. The dispersion of the rates of inflation of these last prices was larger than for the prices of tradable goods.

[5] This equation implies that the relative price of the tradable goods between two countries follows a stationary process if the ratio of their qualities follows such a process. Canzoneri et al. (2001) obtain this result for the European Union countries over the period 1973-1997, by using a unit root test on panel data.

[6] The deepening of the integration of the European goods market, to which the introduction of the euro is contributing, could increase the specialisation of each country in specific segments of the tradable sector. The prices of the tradable good, would aggregate elementary prices in proportions that would differ more and more between countries. So, these prices should diverge instead of converging over time. When we assume that the quality of the tradable good differs between countries, we assume that this difference was not taken into account in the comparison of prices, which OECD carried out for the year 1990, nor in the calculation of the national price indices since this date. However, it is likely that a part of the variations in quality was included in the price indices and that this part differed across countries.

[7] The observations of the year 1995 are necessary because of the presence of lagged endogenous and observable exogenous variables in the model.

[8] We remind that all the variables were detrended. Moreover, economic variables have a strong persistence. We could have made better forecast after 2002, for instance by using the OECD forecasts (we would still have had to adjust them on the national accounts data). However, this would have been cumbersome, and the simplicity of the assumption of static forecasts will make our economic interpretations clearer.

[9] It is very difficult to give a clear interpretation of the evolution of these two macroeconomic indicators in terms of precise social events, which would have occurred in Germany. For example a temporary decrease in the power of the trade unions could simply result from a temporary wages moderation following the gain of huge advantages by the workers.

[10] Business condition analysts interpreted this behaviour as a revision by the ECB of its policy, under the influence of the poor performances of growth in Germany, France and Italy. One can also notice that the official inflation target of the ECB, a ceiling of 2% per year, was exceeded in 2000, 2001 and 2002.

[11] Each price, before its correction, was equal to 1 in Germany in 1995. The common value of 1.074 resulted from the removal of the same trend from each series of price.

[12] The model assumes that foreign trade takes place only for the tradable good. This is obviously wrong and leads to some overestimation of the commercial surplus of the tradable sector. The equilibrium of both sectors was restored by an underestimation of the autonomous demand for tradable good and some overestimation of the autonomous demand for the non-tradable good.

[13] This is not quite right. The inflation rule followed by the ECB creates an undetermination of the price levels and the exchange rate for the steady state model (these variables can be anything in a linear variety with dimension one). Actually, the model presents the property of hysteresis, which means that the long run values of nominal variables depend on their initial values.