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Abstract

The *Balassa-Samuelson* (BS) model is evaluated in eight of the eleven EMU countries. This model suggests that productivity differentials between traded and non-traded goods sectors generate sectoral inflation differentials (dual inflation). Furthermore, differentials in the *degree of dual inflation* induce inflation differentials between countries. The *standard* BS model implies a cointegration relationship between relative prices and sectoral productivities. While this link generally seems to exist, the magnitudes of the parameter estimates are not in accordance with the theoretical model in most countries. Since the presumed uniformity of sectoral wages is rejected in most cases, relative wages are allowed to enter the estimation. This *extended* BS model is endorsed by the data in every country. Simulations based on these results are carried out to quantify possible inflation differentials. Setting EMU-wide inflation equal to 2% and assuming that PPP holds for traded goods, the projected inflation varies around the EMU-average within a margin of some $\pm$ 1 percentage points accross the countries.

1. INTRODUCTION

According to the Maastricht Treaty, the European Central Bank (ECB) has to define its monetary policy so as to achieve price stability in the EMU area as a whole. This implies a single money supply and a single monetary policy for EMU countries, but this does not rule out the possibility of inflation differentials among countries.

The most popular theory to explain inflation differentials on a non-monetary basis is the Balassa-Samuelson (BS) hypothesis. These authors observed that productivity growth has historically been faster in the traded goods sector than in the non-traded goods sector. Labour is a perfectly mobile and homogenous factor in the BS model implying nominal wage equalization. A rise in productivity in the traded goods sector will bid up nominal wages in the entire economy; producers in the non-traded goods sector will only meet the higher wages if there is a rise in the relative price of non-traded goods. Within a country, differentials in sectoral productivity growth induce sectoral differences in inflation (dual inflation) but, when countries are compared, differences in the degree of dual inflation translate into real exchange rate variation.

The object of this paper is to explore empirically the relationship between sectoral productivity differentials and sectoral relative prices and to infer the potential for inflation differentials in EMU. The relevant point is that these inflation differentials will have a different nature. While monetary factors explain most of inflation differentials between countries with different countries, inflation differentials in a monetary union are determined by real factors and, depending of their source, they may call for real adjustment.
The study covers eight of the 11 EMU countries. Full coverage was unfeasible due to the lack of sectoral data. Analysis of the long- run cointegration relationships is carried out using the FIML procedure suggested by Søren Johansen. The estimation results are used in simulations to quantify the magnitude of inflation differential among countries.

The BS model is taken as initial reference, but we introduce a variation in the model which contributes to make it more realistic. Indeed, the neoclassical framework upon which the BS model is built introduce some restrictive assumptions. In particular, the assumption of perfect labour markets is hardly palatable, given the high degree of rigidities in the European labour markets. If this assumption is relaxed, the hypothesis of nominal wage inequality does not necessarily hold anymore. Actually, relaxing this hypothesis has a crucial importance to validate the productivity hypothesis, and our theoretical model takes into account this fact and, along the traditional BS model, we present an extended version which allows for divergence in nominal wages.

According to the results, there is a long-run relationship between sectoral productivity differentials and sectoral price differentials. Moreover, in most countries a plausible cointegration vector can only be defined when relative wages enter the estimation. The obvious reason for this is that the BS assumption of uniform wage development in the two sectors is rejected in most cases.

The simulations extrapolate past trends in productivity and the results of the cointegration analysis. They indicate that -- even if the assumed inflation target of 2 percent for the whole area is met -- inflation differentials will persist among the countries concerned. In some countries inflation is projected to be around 3 percent p.a. whereas in some other countries the projection is around 1 percent p.a. As it turns out, countries with a high inflation history, such as Italy or Spain, are above average. However, projected inflation in Belgium is among the high ones as well. Germany, France, Austria and Finland are consistently projected to show an inflation rate below the area-wide target.

It is worth insisting that the model focuses on real factors and neglects monetary factors as a source of inflation. In the past, these factors seem to have explained much of inflation differentials between high- and low-inflation countries. This abstraction from monetary factors explains the *a priori* surprising results that Belgium is among the high-inflation countries and Finland among the low inflation countries in spite of their respective inflation records in the past.

How should these results be interpreted in the context of EMU?. Although in the conclusions, we will extend on this, it is worthwhile to underline here two points.

First, making inferences based on the BS framework may be inadecuate, because it relies on perfect competitive market assumptions. As a consequence, the conclusion of their model was that inflation differentials is a by-product of real convergence among countries. However, there may be other sources behind sectoral productivity differentials related to demand factors or to the inefficiencies in the labour and product markets. If this is the case, inflation differentials are interpreted under a completely different prism and there is a role for national governments to play. Second, simulations are valid only under the assumption that past trends continue. Obviously a monetary union is a fundamental shock which may induce fundamental changes in the behaviour of agents and markets, with repercussions in the behaviour of productivity and inflation differentials.

The rest of the paper is organised as follows. We next present the model and derive the relationship between inflation and productivity differentials. In section 3, earlier empirical evidence is discussed. Section 4 presents the data and discusses them. Section 5 reports results of estimation and testing in a cointegration framework. In Section 6, a set of simulation exercises is carried out in order to study potential inflation differentials between EMU countries. Section 7 summarises the paper and draws some conclusions.

2. THE MODEL

Balassa (1964) and Samuelson (1964) were the first to suggest that differences in sectoral productivity growth are associated with changes in relative prices between countries. Since labour is assumed to be mobile between sectors, *nominal* wages tend to equalise. Furthermore, *real* wages in each sector, measured in terms of their own prices, are equal to marginal productivity. Balassa and Samuelson noted that productivity tends to grow faster in the tradable goods sector because technological progress is embedded in new capital and tradable goods are more capital intensive than services. All this implies that productivity growth differentials in favour of traded goods are reflected in higher non-traded goods inflation. As a result, countries with higher productivity growth tend to have higher aggregate CPI inflation and their real exchange rate, that is, the relative price of foreign goods to domestically produced goods (measured in domestic currency) tends to appreciate.

It is important to note that productivity differentials do not only arise from technological factors. Bergstrand (1991) has emphasised that demand factors may play also an important role. Since demand for services and, more arguably, public expenditure increasemore than proportionally with income, i.e. their income elasticity is higher than one, inflation tends to be higher in thesesectors. Finally, productivity growth may also arise from rigidities in market and labour products (de Gregorio et al. (1993,1994). Excessive wage pressures in the tradable sector may lead to employment adjustments in the tradable to maintain competitiveness; on the contrary, in the non-tradable sector, which is less exposed to competition employers may react to these wage pressures with an increase of prices. Thus, the combination of wage pressures plus market rigidities may also account for the productivity differentials. Identifying the actual source of productivity differentials is beyond the scope of the paper, but this remarks are important for the interpretation of the results

The productivity hypothesis can be decomposed into two statements which will be formally presented below. First, sectoral inflation differentials (="dual inflation") are due to productivity growth differentials between the two sectors. Second, dual inflation induces real exchange rate variability which, in the case of EMU, will be reflected in inflation differentials among countries.

2.1 Productivity differentials and dual inflation

In the BS model it is standard to assume two production factors, labour (L) and capital (K), which are fully employed in the production of two types of goods: tradables (T) and non-tradables (N). Output in each sector (Y_i , $i=T,N$) is determined by a Cobb-Douglas production technology:

$$\begin{gathered} Y_T=A_T L_T^{\theta} K_T^{1-\theta} \\ Y_N=A_N L_N^{\gamma} K_N^{1-\gamma} \end{gathered} \qquad (1)$$

Each sector differs in the labour intensity of production (θ and γ, respectively) and in the technology content captured by A_i. Optimization implies that under perfect competition the interest rate (R) and the nominal wage in each sector (W_T, W_N, respectively) fulfill the following conditions:

$$\begin{gathered} R=(1-\theta)A_T(K_T/L_T)^{-\theta}=P_{REL}(1-\gamma)A_N(K_N/L_N)^{-\gamma} \\ W_T=\theta A_T(K_T/L_T)^{1-\theta} \\ W_N=P_{REL}\gamma A_N(K_N/L_N)^{1-\gamma} \end{gathered} \qquad (2)$$

where $P_{REL}=P_N/P_T$ is the relative price of non-tradables. It is convenient to express these equilibrium conditions in logarithmic terms[1]:

$$\begin{gathered} r=log(1-\theta)+a_T-\theta(k_T-l_T)=log(1-\gamma)+q_N+p_{REL}-\gamma(k_N-l_N) \\ w_T=log\theta+a_T+(1-\theta)(k_T-l_T) \\ w_N=log\gamma+a_N+p_{REL}+(1-\gamma)(k_N-l_N) \end{gathered} \qquad (2')$$

where a_i represents total factor productivity in the sector concerned.

[1] Throughout the paper, lower case letters refer to variables in logs.

We follow the standard assumption that capital markets are perfectly competitive and integrated, so that the interest rate is exogenously given by the international financial market.
As far as the labour market is concerned, however, we consider two alternatives. The first fits with the *standard* procedure and assumes that labour is perfectly mobile between sectors. As a result, nominal wages are homogeneous, $w_T=w_N=w$. Solving for capital-labour ratios in equation (1) and substituting in the wage equation, we obtain the following expression for the relative price:

$$p_{REL}=p_N - p_T= c+(\gamma/\theta)a_T - a_N \qquad (3)$$

where c is a constant term which includes the real interest rate and factor intensities which are taken as given.

An alternative specification is suggested by two facts about labour markets. First, labour is not homogenous due to differences in skills or human capital. Secondly, we also know that labour is not fully employed, due to imperfections or rigidities. These matters may also be reflected in persistent differences in the evolution of sectoral wages. In order to take account of this possibility, we consider an *extended* version of the previous solution:

$$p_{REL}=p_N - p_T=c+(\gamma/\theta)a_T - a_N-\gamma(w_T - w_N) \qquad (4)$$

where differences in sectoral wages also play a role.

Expressing (4) in terms of differences, the *productivity hypothesis* follows:

$$\Delta p_{REL}=\Delta p_N - \Delta p_T=(\gamma/\theta)\Delta a_T - \Delta a_N-\gamma(\Delta w_T - \Delta w_N) \qquad (5)$$

Note that the ratio γ/θ is larger than one since non-tradable sector goods, such as services, tend to be more labour-intensive than tradable goods. Under the *standard* assumption wages behave uniformly and the last term in (5) drops out. The resulting specification corresponds to the standard BS equation familiar in the literature (see e.g Froot & Rogoff, 1995, p. 1675).

In this case, higher productivity growth in the tradable sector will be reflected in higher inflation in the non-tradable sector. In the *extended* model -- with all terms present in (5) -- changes in sectoral wages might even reverse the inflation projection. This happens under the strong condition that the growth of nominal wages in the tradable goods sector exceeds that in the non-tradable sector by a sufficient margin.

2.2 Dual inflation and the real exchange rate

The real exchange rate (*rer*) is defined as the relative price of goods produced abroad (measured in domestic currency) to domestically produced goods:

$$rer = (e+p^*) - p \tag{6}$$

where e is the nominal exchange rate and p, p^* refer to the overall level of (consumer) prices in the home country and abroad, respectively. An increase in *rer* reflects a real exchange rate depreciation. The aggregate price measures, p and p^*, are weighted averages of the prices in the two sectors:

$$\begin{gathered} p=(1-\delta)p_T+\delta p_N \\ p^*=(1-\delta^*)p_T^*+\delta^* p_N^* \end{gathered} \tag{7}$$

where δ, δ^* is the share of non-tradables in consumption. Substituting these expressions in (6) and expressing the result in terms of differences, we obtain:

$$\Delta rer = [(\Delta e+\Delta p^*_T)-\Delta p_T]+[\delta^*(\Delta p^*_N-\Delta p^*_T)-\delta(\Delta p_N-\Delta p_T)] \tag{8}$$

In EMU, Δe is, by definition, zero. Let us, in addition, assume that in the long run purchasing power parity (=PPP) holds in the tradable goods sector. Under the assumption that $\Delta p_T=\Delta e+\Delta p^*_T$, changes in the real exchange rate can be expressed in terms of sectoral inflation differentials: $\Delta rer = [\delta^*(\Delta p^*_N-\Delta p^*_T)-\delta(\Delta p_N-\Delta p_T)]$. Substituting *(4)* in this expression, inflation differentials between countries depend on sectoral productivity -- and wage -- differentials in the two countries concerned:

$$\Delta p-\Delta p^*=\delta[(\gamma/\theta)(\Delta a_T-\Delta a^*_T)-(\Delta a_N-\Delta a^*_N)]-\delta\gamma[(\Delta w_T-\Delta w_N)-(\Delta w^*_T-\Delta w^*_N)] \tag{9}$$

where, for simplicity, we have assumed that all parameters (δ, γ *and* θ) are the same for both countries[2]. According to this expression -- provided that wages grow at the same rate in both sectors -- EMU countries with higher relative productivity growth in the tradable goods sector will suffer from higher inflation.

[2] For the empirical work, this is an irrelevant assumption. If it is relaxed, expression (9) just becomes more complicated:
$\Delta rer=[(\delta^*\gamma^*/\theta^*)\Delta a^*_T-(\delta\gamma/\theta)\Delta a_T] - [\delta^*\Delta a_N-\delta\Delta a_N] - [(\delta^*\gamma^*)(\Delta w^*_T-\Delta w^*_N)-\delta\gamma(\Delta w_T-\Delta w_N)]$.

3 EARLIER EVIDENCE

Empirical studies have followed two avenues. The first is to study directly the relationship between productivity differentials and real exchange rates. The second concentrates on the link between productivity differentials and dual inflation.

Most of the studies which opt for the first approach attempt to explain the well-documented failure of the PPP-proposition by considering permanent shifts in the real exchange rate due to real factors such as productivity differentials[3]. Using OLS regressions (Hsieh,1982, and Froot & Rogoff, 1991) or the more sophisticated cointegration analysis (Strauss, 1996), the overall conclusion is that productivity differentials are closely related to the evolution of the real exchange rates. Results on the second approach, followed among others by De Gregorio et al. (1994), Canzoneri et al. (1998) and Micossi and Milessi-Ferreti (1994) conclude that higher productivity growth in the tradable goods sector implies higher non-tradable goods inflation.

It is important to stress that monetary factors play a relevant role in determination of nominal and also of real exchange rates between countries. As a matter of fact, they may have been the dominant source of inflation differentials between countries in Europe in the past. Because of this, it is not straightforward to specify an empirically well-defined direct link between productivity differentials and (real) exchange rates when historical data is used. It seems highly likely that a plausible model (according to the first approach discussed above) should *de facto* include monetary factors in the empirical specification. In EMU, by contrast, monetary divergences will disappear and inflation differentials will be exclusively due to real sources.

These considerations make the second approach more appropiate to study potential inflation differentials in EMU and therefore we will explore the link between sectoral productivities and prices. However, our study is quite different from the previous contributions in several respects. First, the sectoral breakdown is different. Second, the econometric specification is more general and testing is more complete than in earlier contributions. Third, when defining our preferred specification we follow the 'general to specific' modelling strategy.

[3] See McDonald (1998) and Rogoff (1996) for recent surveys on PPP and Rogoff & Obstfeld (1995) for a reappraisal. There are other structural explanations for PPP deviations, but contrary to the Balassa-Samuelson hypothesis, they emphasise PPP deviations in the traded goods sector: portfolio or asset accumulation models (Mussa, 1984), terms of trade models (Neary, 1988) and pricing-to-market models. Evidence on PPP in the traded goods prices, albeit not robust, is stronger than when the overall price indices are considered (see Froot & Rogoff, 1995).

This indicates testing of not only the BS hypothesis as such but also its underlying assumption that sectoral wages are homogeneous. Finally, our preferred specification which accords to the extensions discussed in the theoretical section above is a novelty in the literature. We hope that it adds realism to the Balassa-Samuelson model.

Since our simulations below will address the issue of potential inflation differentials in a monetary union, it is also of interest to refer to a couple of recent studies on inflation differentials in existing monetary unions: USA and Spain. Cecchetti et al (1998) study convergenge of prices in 15 US cities using panel data for 1918-95. In six consecutive non-overlapping ten year periods, the *average* annual inflation range was at lowest 1 percentage point and at highest 1.6 percentage points *per annum*. In a similar study on Spain, Alberola & Marqués (1998) find that the range of average inflation differentials *per annum* among Spanish provinces is even larger, ranging between 1.2% and 2.5%. Remarkably, these differentials have remained quite similar in periods with high and low aggregate inflation.

4 THE DATA AND SECTORAL DISAGGREGATION

4.1 The sectoral disaggregation

The Balassa-Samuelson model emphasizes differences between the traded goods sector and the non-traded goods sector. The *Scandinavian Inflation Model*[5] also has the two-sector property. Here, the *open sector* is the leader and the *sheltered sector* is the follower. Production in the former is subject to foreign competition whereas in the latter it is not. This is in full accordance with the BS set-up. So is much of the rest of the Scandinavian inflation model as well.

In the empirical applications of these models, it has been common to operationalize the traded goods sector (= open sector) as the manufacturing industry. De Gregorio, Giovannini & Wolf (1994) calculate, for 14 OECD economies, the average share of exports in the overall production in each industry in 1970-85 and use shares higher than 10% as the criterion of tradability. Accordingly, they include agriculture and mining, manufactures and trasport in the tradables sector. The rest of services make up the non-tradables sector.

The inclusion of agriculture is, however, controversial. First, in many countries, agricultural production has been heavily subsidized and prices administratively determined. As a consequence, producer prices, consumer prices

[5] See Lindbeck (1979), e.g.

and export prices of agricultural products do not necessarily have much to do with each other. If the common agriculture policy of the EU, for example, has exacerbated these features in some European countries more than in others, inclusion of agriculture could induce a bias in estimation of relative prices. Second, if the number of self-employed dominates in agriculture employment, analysis of relative wages may be misguiding. Implications for inflation pressures of a deviation of wages from productivity are not straightforward either. Third, partly reflecting features above, measurement of agricultural labour productivity in the System of National Accounts (SNA) is particularly problematic and differences in the related bias may induce differences in estimates accross countries. Finally, in all countries, the output share of agriculture has diminished drastically over the past decades. In some countries the decline took place earlier and in some others later. Because changes in the size of the agriculture have been so large, inclusion of agriculture into any of the two sectors may dominate the examination of relative output shares.

In the public sector, measurement of productivity in SNA is far from straightforward either. In addition, prices of public goods and services are not determined in a process in which costs and productivities play their proper role. So, the data generating process differs considerably from that in the private sector of the economy. If one expects to find a well-defined time-invariant relationship between productivity growth and price setting, this can hardly be found in the public sector where price setting may also be influenced by political considerations.

Given the points made above, the sectoral breakdown applied in this work is the following[5]:

Traded goods sector (*T*):

Manufacturing industry + Transportation

Non-traded goods sector (*N*):

The rest of the economy excluding Agriculture and Public sector

4.2 The data

The annual data used in econometric analysis covers 8 countries:

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[5]- This sectoral disaggregation also differs from that in Canzoneri et al (1998), e.g, which includes agriculture in the traded goods sector, on the one hand, and transportation and public sector in the non-traded goods sector, on the other hand.

Germany, France, Italy, Spain, Belgium, Netherlands, Austria and Finland[6]. At the outset, we wished to cover each of the 11 EMU-economies. This proved impossible because adequate sectoral data was not available for all countries. For Portugal, which appears in the graphs, the existing data set is too short for econometric analysis. The series used in the analysis are, for each sector:

Value added deflator, P_i;
Output, GDP at constant prices, Y_i;
Employment, number of employees, L_i;
Productivity, $Q_i = Y_i/L_i$;
Wage sum, WS_i;
Employers' social security contributions, SS_i;
Production wage, $W_i = (WS_i+SS_i)/L_i$.

In the present context, four points are worth stressing. First, since we are interested in price differentials, the relevant wage variable is the production wage per worker, which includes payroll taxes. In this respect, our choice differs from that of many other studies. Second, productivity will be proxied by labour productivity as most studies do and not, as the theoretical model implies, by total factor productivity. The reason is that data on sectoral capital stocks are difficult to obtain and measures of total factor productivity are subject to discussion (see Pilat, 1996)[7]. Third, employment is measured by the number of employed persons since data on working hours were not available. This also implies that labour productivity is output per worker, not per hour which would be a more appropriate measure. The matter may cause problems for estimation in particularl in countries where the share of part-time work has increased considerably[8]. Fortunately, this is a major concern, among the countries

[6]- The data come from the OECD (Statistical Compendium 97/2). The length of the series varies from country to country. For Germany, there are observations for 1960-1993. For most of the countries, the data, however, only begin in the mid-1970s and end in 1993-95. For Spain, the sectoral OECD data start at 1985 but they were augmented with data of the Bank of Spain to begin in 1965.

[7] For some countries, we actually considered total factor productivity (TFP) in the two sectors. We abandoned this choice because certain unconvincing results.In Spain, for instance TFP indicates a steady and permanent decline in the *level* of TFP in the service sector which is difficult to accept. This result is probably due to arbitrary measurement of the level of capital stock in the non-traded goods sector.

[8] This issue is more important in the *standard* BS model according to (4) above whereas in the *extended* BS model according to (5) it is less so. This is because the latter model includes both productivities and wages which are both

considered, only in the Netherlands. Still, this issue will be reconsidered below. Finally, although much of the literature discusses real exchange rates in terms of CPI inflation, CPIs can not be used in sectoral analysis. This is because CPIs are based on consumption baskets which cannot be disaggregated according to the sectoral breakdown applied in National Accounts.

4.3 A preliminary look at the data

A first look at the Balassa-Samuelson hypothesis is to consider the sectoral data on productivity and prices in various countries (see graphs 1 to 9). The first point to note is that, over the whole sample period, productivity in the traded-good sector has grown more than in the non-tradable sector, as panel (a) in each graph shows. According to the BS productivity hypothesis, this should mean that prices in the non-tradable sector increase more than in the traded-good sector. Panel (b) in each of the graphs shows that this has, as a rule, been the case. The core of the productivity hypothesis is in panel (c). Relative prices of non-tradables have tended to rise as the relative productivity in the tradable goods sector has increased. This obviously gives support to the Balassa-Samuelson hypothesis.

In Table 1, the same information is summarised in terms of rates of growth for the latter years of data. On the one hand, for the chosen period, data for all countries are available. On the other hand, for evaluation of trends in the years to come, the more recent past may well be most indicative. Table 1 contains some points of particular interest. First, sectoral inflation differentials range from 3.3% in Spain to close to nil in the Netherlands. Second, German productivity[9] in this period has grown slightly more in the non-traded good sector. Third, Spain, which is one of the potential catching-up countries has displayed low productivity growth in both tradable and non-tradable goods. This challenges the presumption that productivity growth is faster in countries with lower *per capita* income. Fourth, in addition to the Netherlands, productivity

measured per head. Thus, as far as the relationship between price setting, productivities and wages is concerned, potential biases will cancel out. As it will be seen, our results according to both models are qualitatively very similar. This could be an indirect indication that the bias due to the productivity measure is probably not of first-order importance.

[9] Note that, for the nineties, the figures for productivity growth in Finland are not representative. In the early 1990s, the level of GDP fell by 13 percent within two years. At the same time, the unemployment rate rose from 3% to 20%. Particularly in manufacturing, employment declined much more than production. As a result, Finnish manufacturing faced a few years with productivity growth exceeding 10 percent annually.

Chart 1 GERMANY, 1960-1995

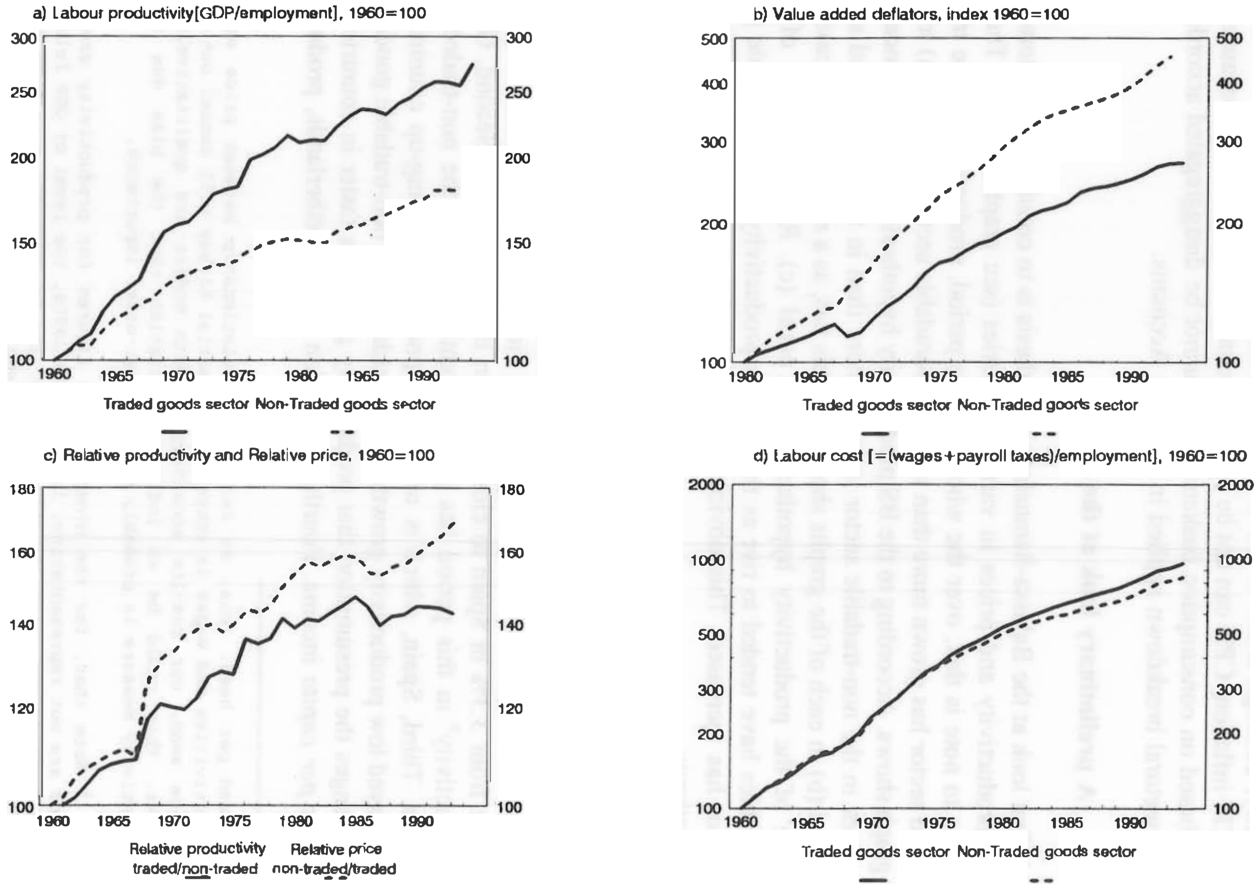


Chart 2 FRANCE, 1977-1995

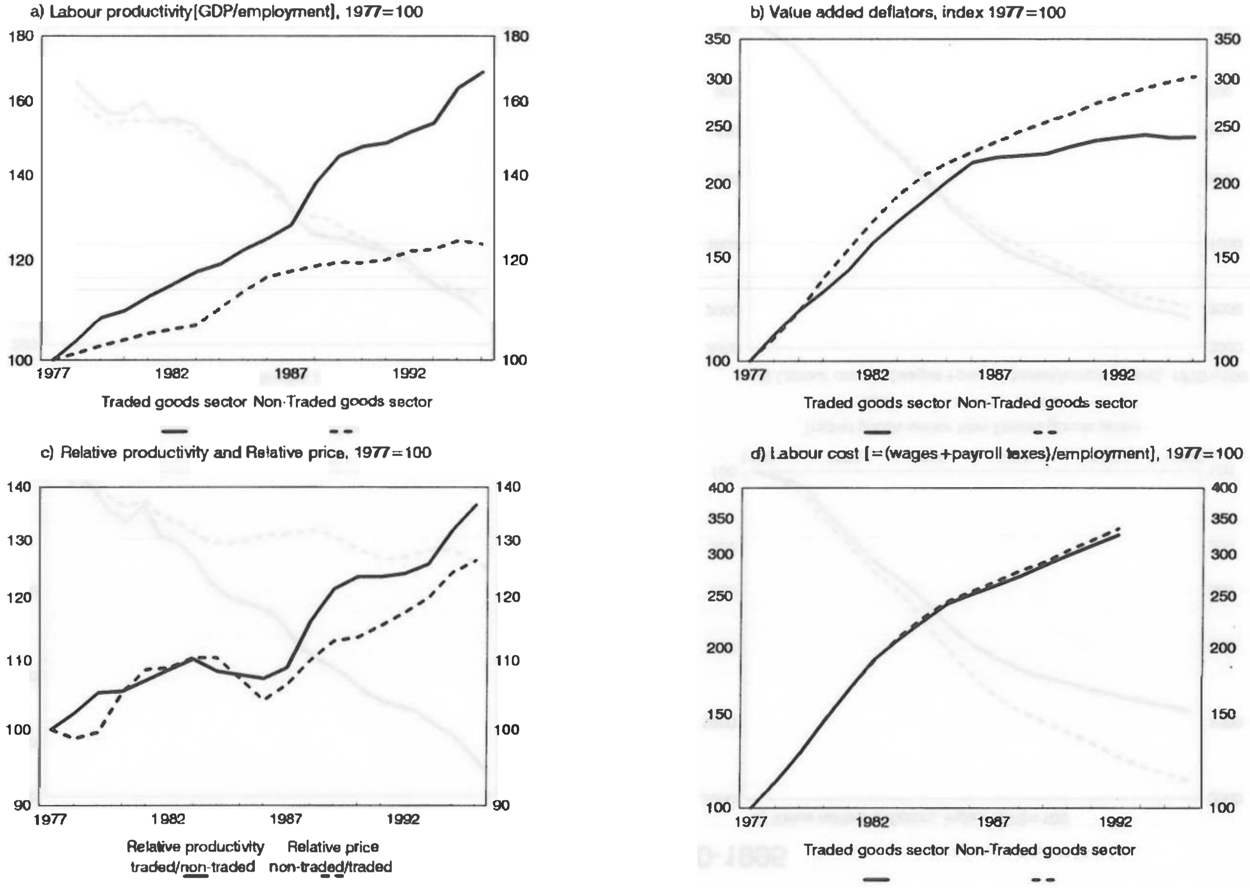


Chart 3

ITALY, 1970-1995

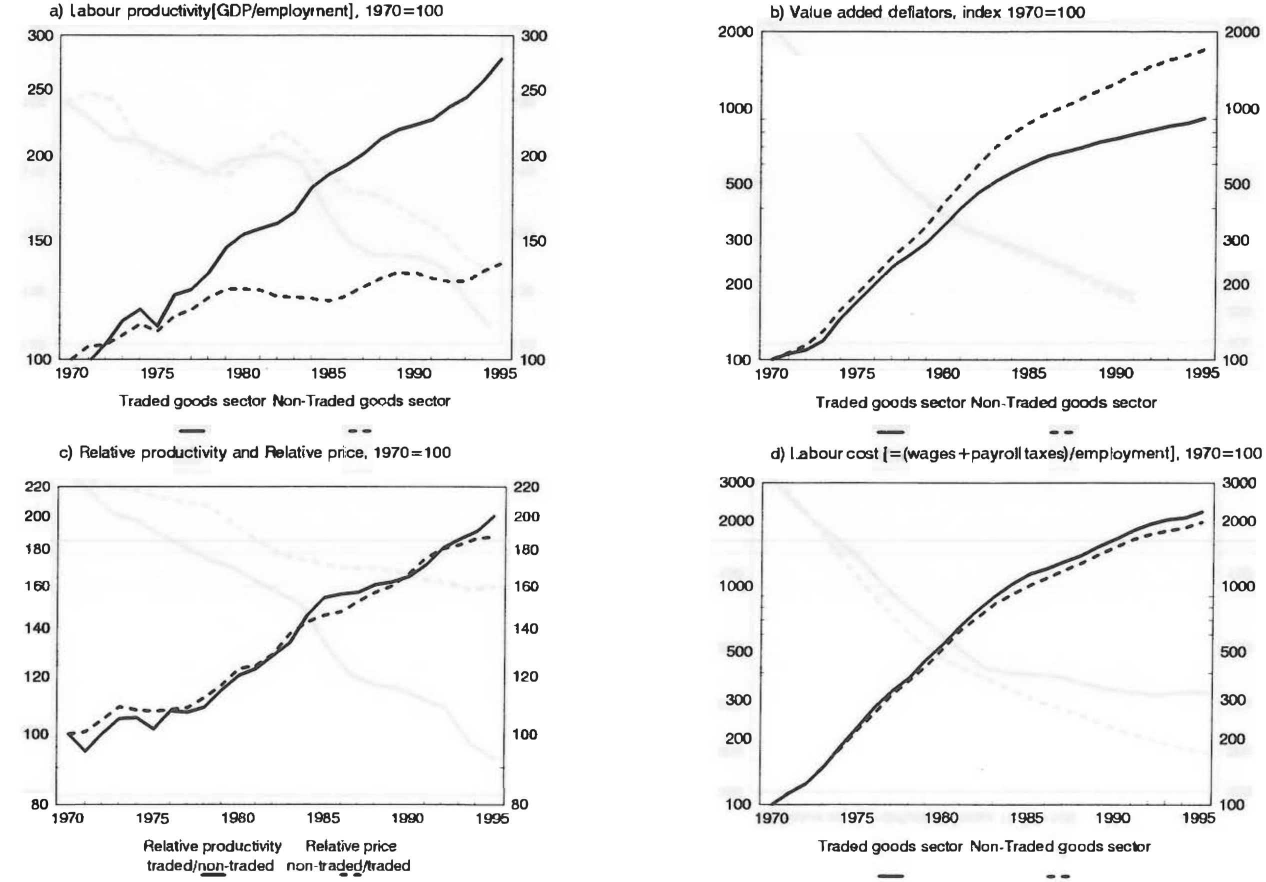


Chart 4

SPAIN, 1965-1995

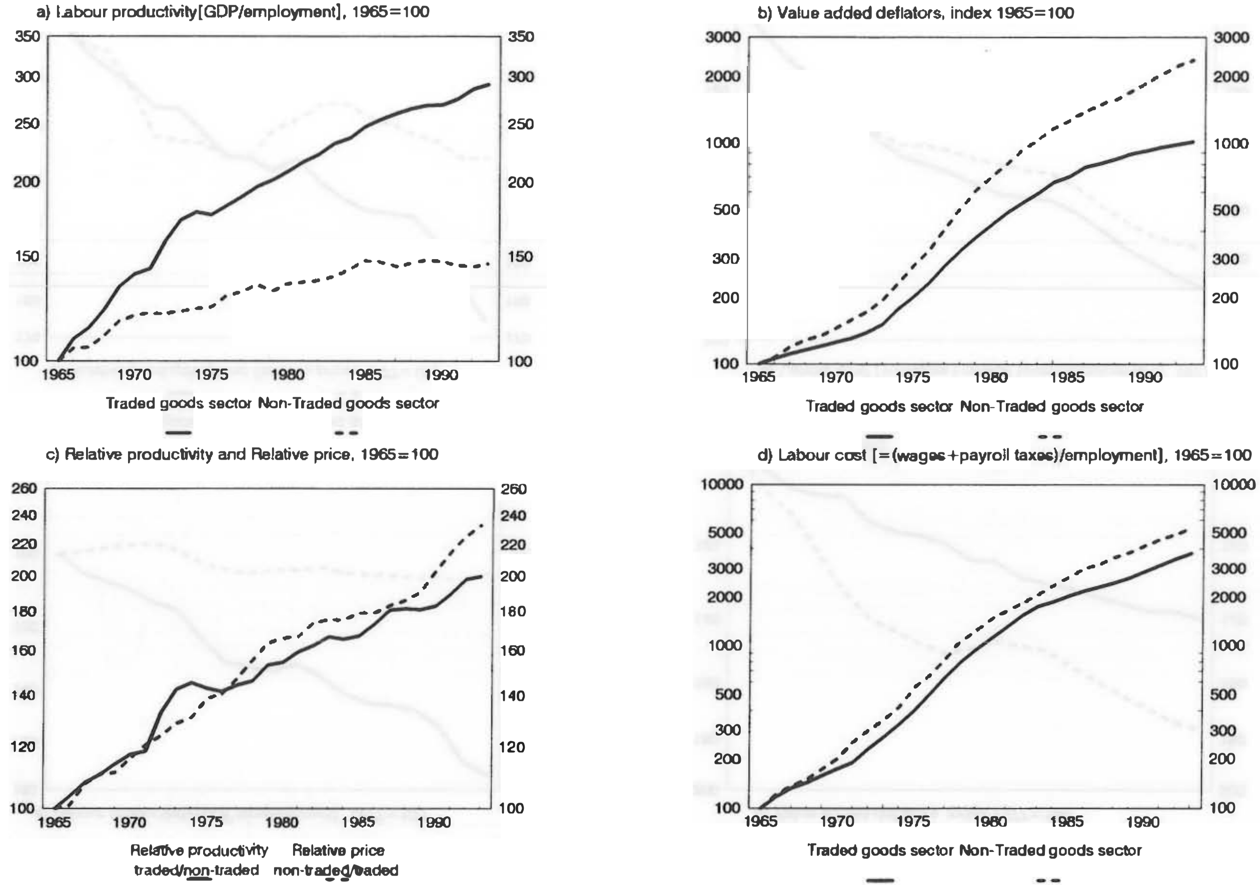
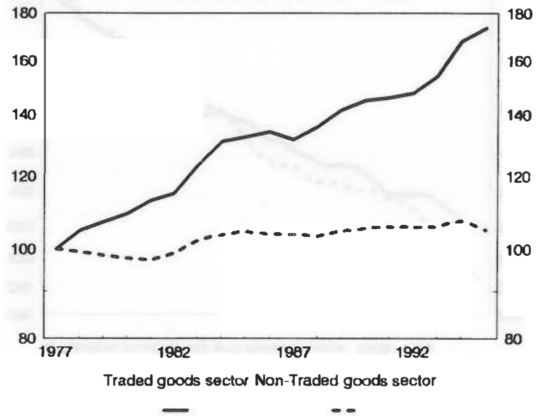


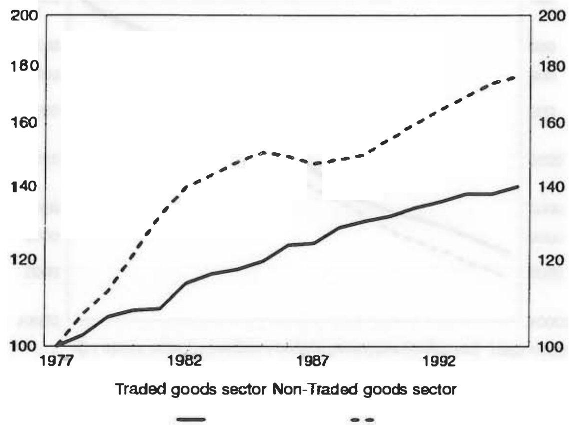
Chart 5

NETHERLANDS, 1977-1995

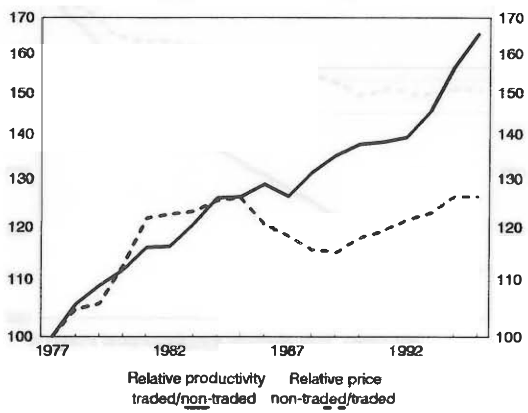
a) Labour productivity[GDP/employment], 1977=100



b) Value added deflators, index 1977=100



c) Relative productivity and Relative price, 1977=100



d) Labour cost [=(wages+payroll taxes)/employment], 1977=100

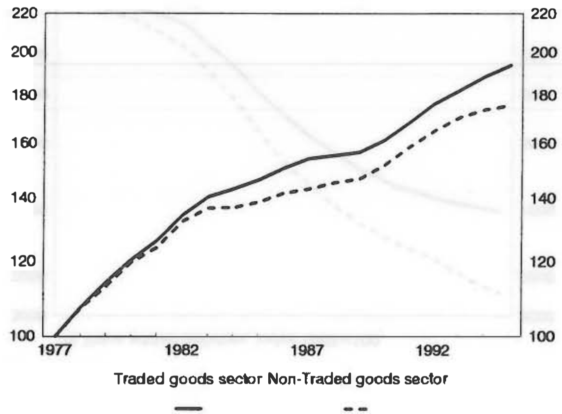


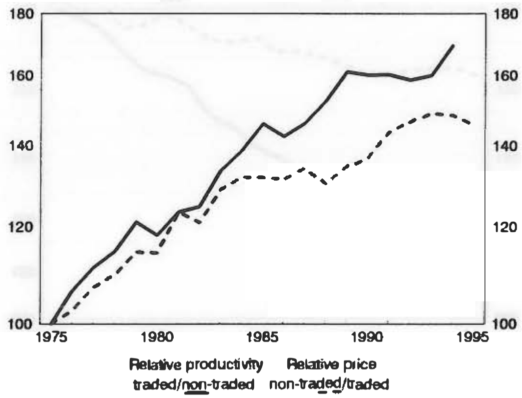
Chart 6

BELGIUM, 1975-1995

a) Labour productivity[GDP/employment], 1975=100

b) Value added deflators, index 1975=100

c) Relative productivity and Relative price, 1975=100



d) Labour cost [=(wages+payroll taxes)/employment], 1975=100

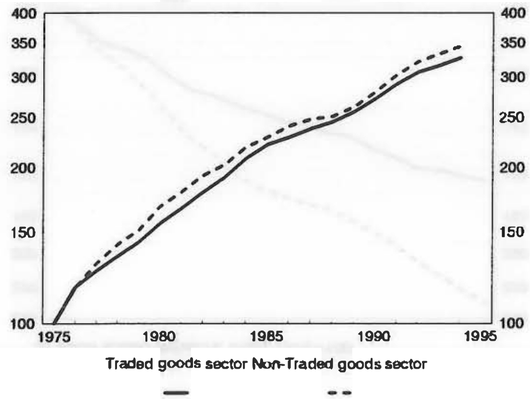
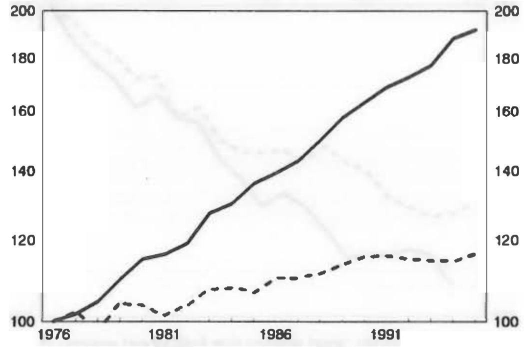


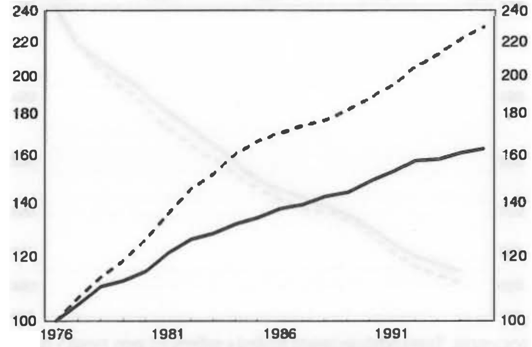
Chart 7 AUSTRIA, 1976-1995

a) Labour productivity[GDP/employment], 1976=100



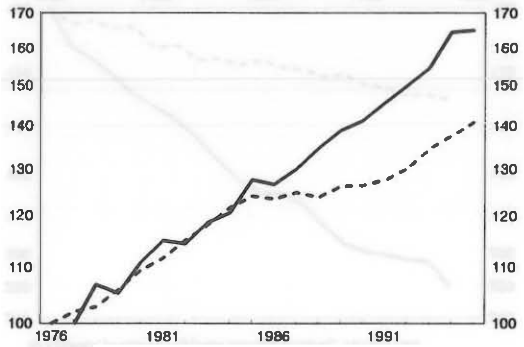
Traded goods sector Non-Traded goods sector

b) Value added deflators, index 1976=100



Traded goods sector Non-Traded goods sector

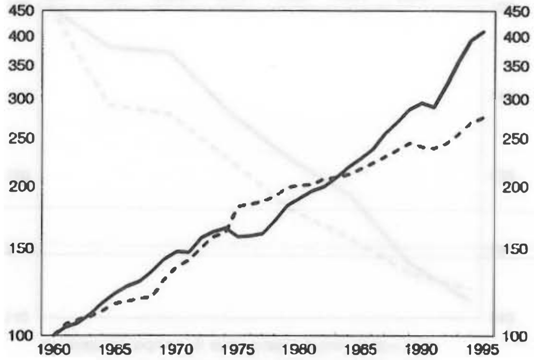
c) Relative productivity and Relative price, 1976=100



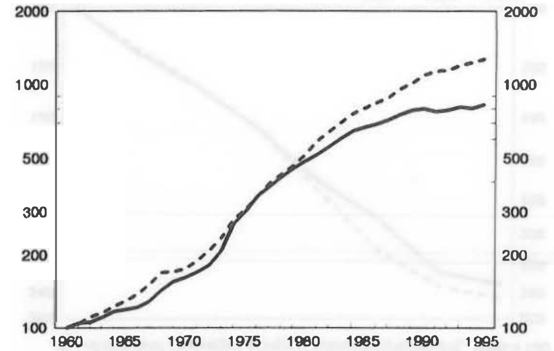
Relative productivity traded/non-traded Relative price non traded/traded

Chart 8 FINLAND, 1960-1995

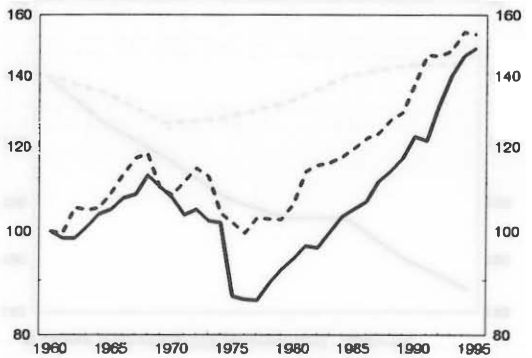
a) Labour productivity[GDP/employment], 1960=100



b) Value added deflators, index 1960=100



c) Relative productivity and Relative price, 1960=100



d) Labour cost [=(wages+payroll taxes)/employment], 1960=100

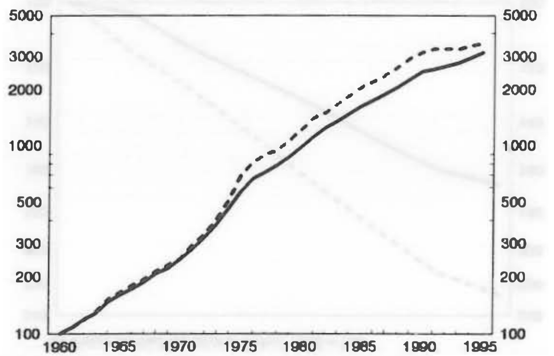
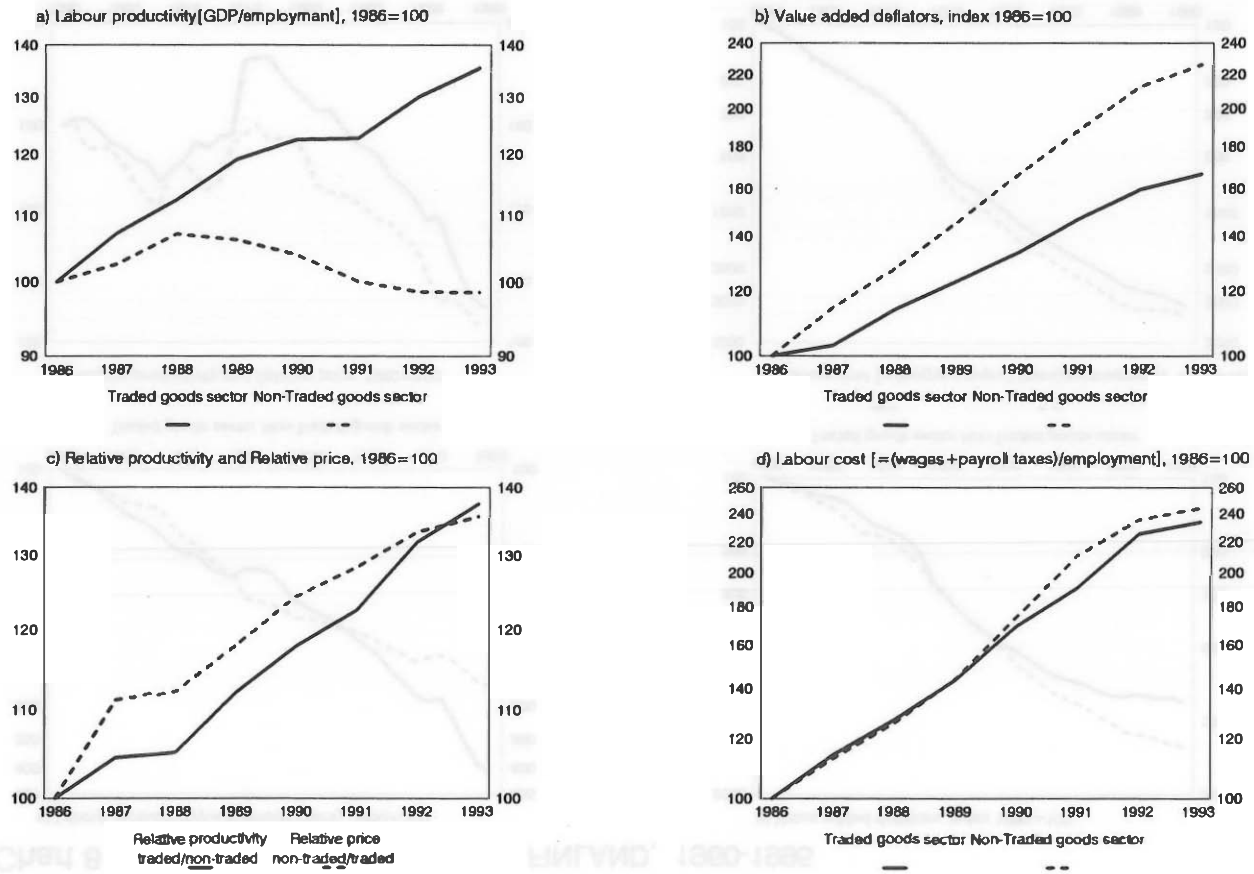


Chart 9 PORTUGAL, 1986-1993



performance in the non-traded goods sector has been particularly poor in Spain and Portugal. This challenges arguments according to which the catching-up process is presently led by the service sector[10].

The final point to address is as follows. While the standard BS model presumes uniform wage growth -- due to sectoral labour mobility -- the data do not seem to be in accordance with this presumption. Indeed, panels (d) indicate that, in some countries, there are important divergences in sectoral wages. This suggests that -- according to our theoretical model -- relative wages may play an additional role in the long-run relationships between sectoral prices and productivity growth differentials. This possibility will be tested as part of the cointegration analysis in the next section.

Table 1
Average annual changes in labour productivity and sectoral differentials in productivity growth and price changes, percentage points

	Period	Differential in price increases $\Delta p^N - \Delta p^T$ (A)	Differential in productivity growth, $\Delta q^T - \Delta q^N$ (B)=(C)-(D)	Productivity growth in the traded goods sector, Δq^T (C)	Productivity growth in the non-traded sector, Δq^N (D)
Germany	1985-93	0.8	-0.2	1.2	1.4
France	1985-95	1.2	1.9	3.3	1.4
Italy	1985-95	2.6	2.7	3.9	1.2
Spain	1985-93	3.3	2.1	2.3	0.2
Netherl	1985-95	0.1	2.4	2.6	0.2
Belgium	1985-94	0.9	2.2	3.0	0.8
Austria	1985-95	1.4	2.9	3.6	0.8
Finland	1985-95	2.5	3.5	5.8	2.3
Portugal	1987-93	4.8	4.6	4.5	-0.2

[10] For a discussion see Tyrväinen (1998).

5 COINTEGRATION ANALYSIS

The Balassa-Samuelson model presented in section 2, and the preliminary evidence above, suggest that there probably is a specific long-run relationship between prices, productivity differentials and, potentially, relative wages. The matter is formally examined below using the Full Information Maximum Likelihood (FIML) estimation method suggested by Johansen (1991) and Johansen-Juselius (1990).

As the observation period is fairly short in most cases, potential problems related to overparameterization are obvious. Because of this, each model will be made more parsimonious by imposing *a priori* restrictions derived from theoretical evaluations. This avenue was chosen although we are fully aware that it would be preferable to estimate an unrestricted model in which each variable is allowed to have its own separate dynamic adjustment path.

Two models will be examined. The first is the *standard* Balassa-Samuelson model which relates sectoral price differentials to productivity differentials. In this set-up relative wages play no role. This is because wages are *assumed* to be homogeneous in the two sectors. According to our knowledge, validity of this assumption has not been challenged in earlier papers discussing the BS model. After having rejected wage homogeneity, an *extended* BS model including relative wages is estimated.

5.1 The *standard* Balassa-Samuelson model

Equation (3) above represented the BS hypothesis about determination of dual inflation ($\Delta p_{REL}=\Delta p_N-\Delta p_T$), assuming full sectoral labour mobility and, consequently, homogeneity of nominal wages. The empirical counterpart -- when the proxy for productivity is the labour productivity, q_i -- of the long-run relationship (3), expressed in logs, is

$$p_{REL}= p_N - p_T = c + (\gamma/\theta)q_T - q_N \tag{3'}$$

This expression defines a specific relationship between sectoral price levels and sectoral productivity levels expected to hold in the long run. Furthermore, (3') defines an *a priori* restriction which implies that the long-run parameters associated with p_T, p_N and q_N are equal (in absolute value). Therefore, we combine these variables into a new variable, $(p_{RELt}+q_{Nt})$. Normalizing with respect to it, we arrive at the following empirical equation which will serve as a basis for testing the BS hypothesis:

$$(p_{RELt}+q_{Nt}) - \beta_{QT}q_{Tt} + \varepsilon_t = 0 \qquad (10)$$

If the residual, ε_t, of the two dimensional VAR is stationary, i.e. $\varepsilon_t \sim I(0)$, the series concerned are said to be cointegrated with cointegration vector $[1\ -\beta_{QT}]$.

For inference on cointegration, three sources of information are helpful. The first is the formal Trace test (or/and the λ-max test). Secondly, roots of the companion matrix can be used to examine the number of common trends which helps to define the number of cointegrating vectors. Finally, graphics of the eigenvectors can shed additional light, particularly when the first two procedures do not give a definite answer[11].

The cointegration rank, r, specifies the number of linearly independent stationary relations between the levels of the variables. When the rank is zero, r=0, there is no cointegration. When it is equal to the number of variables, r=n, any linear combination of vectors is stationary which implies that each individual series is stationary. Cointegrating relations are the eigenvectors corresponding to the r largest eigenvalues in the system[12].

For appropriate testing, the Gaussian presumptions must be satisfied. Problems in this respect may reflect an inappropriate lag length, or outliers in the data, or they may simply indicate that the model is not adequate. All alternatives should be studied. As part of the preliminary analysis of the properties of the series in full VAR-models, stationarity tests and exclusion tests were carried out.

Cointegration implies the existence of a time-invariant long-run relationship between the variables. In a model according to (10), the

[11] Statistical inference based on these aspects is sometimes complex. Due to lack of space, we have omitted relevant tables and related discussions from the paper. We simply indicate whether cointegration was found and report the cointegration rank, r. All test results and other relevant material related to inference are available from the authors upon request.

[12] The magnitude cf an eigenvalue λ_i, indicates how strongly the cointegrating relation is correlated with the stationary part of the process. The test for a specific value of r involves the hypothesis that $\lambda_{r+1} = \ldots = \lambda_n = 0$, whereas $\lambda_1, \ldots, \lambda_r > 0$ (see Johansen, 1992). The likelihood ratio test statistic of the hypothesis of r cointegrating vectors in n-dimensional system is given by the so-called Trace statistic. The distribution of the test statistic, which is a non-standard Dickey-Fuller type (involving a multivariate Brownian motion), has been tabulated for the asymptotic case in Johansen & Juselius (1990). The distribution depends on the assumption concerning the existence of the linear trend (yes or no). The distribution has broader tails if the trend is absent.

cointegration vector $[1 \; - \; \beta_{QT}]$ is presumed to act as an attractor[13] which incorporates an equilibrium relationship between the variables. If the system is off the attractor, pressure to correct the deviation emerges. Therefore, a cointegrating relation in (log) levels defines a dynamic error-correction equation in (log) differences. Accordingly, for each (endogenous) variable a difference equation is estimated. In so far as $(p_{RELt}+q_{Nt})$ is considered and allowing two lags in levels - the dynamic equation looks as follows:

$$\Delta(p_{REL}+q_N)_t = \text{possible constant} + \text{possible dummies} + \eta_0 \Delta q_{Tt} + \eta_1 \Delta (p_{REL}+q_N)_{t-1} + \eta_2 \Delta q_{T,t-1} + \alpha \, [(p_{REL}+q_N \; - \; \beta_{QT} q_T)_{t-1}] + \nu_t \qquad (11)$$

A significant constant term in the short-run part allows an intercept in the cointegrating relations and linear trend slopes in the data. The long-run convergence is towards the attractor defined by the β-coefficients and the long-run part of the equation.

The α-coefficient defines the share of the lagged equilibrium error which is corrected in the present period[14]. However, the magnitude of η_0 defines how much of the effect of the present shock (in q_T) is left to be corrected in future periods. If the lagged dependent variable enters significantly the dynamic part of the equation ($\eta_1 \neq 0$), it also influences the adjustment. A significant presence of lagged differenced shock variables ($\eta_2 \neq 0$) has a similar impact. Therefore, it is not sufficient to consider only the size of the α-coefficient when dynamic adjustment is examined.

As far as the dummy variables are concerned, in the Johansen estimations their role differs importantly from their role in standard regressions. The dummies only enter the dynamic part of models and leave the long-run relationships unaffected. Use of *economically meaningful* dummies has been advocated because sudden shifts in variables (e.g. due to oil price shocks or

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[13] Let us consider two non-stationary variables x and y such that y = Ax. A acts as an attractor if there is some mechanism such that if y departs from Ax there will be a tendency to get back near to it. Because of uncertainties, rigidities, contracts etc., the mechanism may not immediately bring the points exactly to the attractor.

[14] Importantly, it is not appropriate to consider a vector as a cointegration vector unless error correction is involved. This is because of the statement of Granger (1986, p. 217) on the special relationship between cointegration and error correction: "Not only must cointegrated variables obey such a model but the reverse is also true; data generated by an error-correction model ... must be cointegrated." This is also why we report the α-coefficients in Tables A1 - A3.

policy interventions) may make estimation of the short-run coefficients in (11) arbitrary. As this also concerns the α's, problems could be generated on inference about error correction.

In estimation, each variable is endogenous at the outset. However, if an α-coefficient is not significantly different from zero, we can condition on the variable concerned. This indicates weak exogeneity. By conditioning, efficiency of the estimation can be increased. Of course, this avenue is only chosen when testing in the full model indicates that conditioning is appropriate.

In the present context, cointegration is not a sufficient condition for acceptance of the BS model. This is because (5) and (10) imply that β_{QT}, which approximates (γ/θ), must be equal to or larger than unity since -- as was discussed in Section 2 -- labour share in the non-tradable goods sector (γ) is presumably larger -- and certainly not smaller -- than that in the tradable goods sector (θ). Thus, the standard version of the BS hypothesis will only be accepted if -- in addition to cointegration -- the hypothesis

$$H_0: \quad \beta_{QT} \geq 1$$

is in accordance with the data.

The inference here is according to the procedure suggested by Johansen & Juselius (1994). They claim that a structure is acceptable only if identification is reached in three different aspects. First, *generic identification* is related to the statistical model. Secondly, *empirical identification* is related to the actual estimated parameter values and their significance. The plausibility of the resulting cointegrating relations applies, however, not only to the signs but also to the magnitudes of the parameter values. Accordingly, last but not least, *economic identification* is related to the economic interpretability of the estimated coefficients of a generically and empirically identified structure. H_0-hypothesis above is a kind of "plausibility condition" which relates to economic identification.

Economic identification is carried out by restricting the β_{QT} parameter to be equal to one and testing the validity of this restriction in a Likelihood Ratio (LR) test. Intuitively, a restriction is validated if the eigenvalues related to the restricted estimation do not differ "too much" from the unrestricted estimation. Each restriction is always compared to the original unrestricted estimation and all r eigenvalues contribute the test statistic which follows the χ^2-distribution with degrees-of-freedom indicated in the tables.

Estimation and results

The results of the estimations of model (10) appear in detail in Table A1 in the Appendix. In the following tables, the column labelled *REST* refers to the restricted model and *FREE* to the unrestricted model. The case which best accords with the data defines the preferred relationship and is marked with a star (*). A summary of the preferred relationships due to this estimation -- as well as the later ones -- is in Table 2 below.

In most cases, the preliminary analysis did not point to any particular problems with respect to the normality of the residuals. Because of signs of excess kurtosis due to extraordinary changes in the differenced data, we included, however, certain dummies[15]. As far as the lag length is considered, misspecification tests indicate that we do not lose anything by restricting it to either 2 or 3 depending on the country. This holds in later estimations as well. In the bivariate VAR, cointegration is found in every country except the Netherlands. A look at the data on relative productivities and relative prices in Netherlands indicates that this is actually what one would expect. Visually, relative prices and relative productivities seem to have little to do with each other particularly in the post-1985 period.

[15] In Finland, the beginning of the "great recession" in 1991 (exacerbated by the collapse of the Soviet Union, Finland's major trading partner) generated extraordinary outliers to the differenced data. In Belgium, dummies for 1986 and 1993 are present. Examination of the data depicted in Charts 6 and 9 in Appendix reveals the source of excess kurtosis in each case.

Table 2 Summary of cointegration analysis

Standard BS: $\beta_{PREL}p_{RELt} - \beta_{QT}q_{Tt} + \beta_{QN}q_{Nt} = 0$
with the *a priori* restriction $\beta_{PREL} = -\beta_{QN} = 1 = \beta_{PQN}$.

Extended BS: $\beta_{PREL}p_{RELt} - \beta_{QT}q_{Tt} + \beta_{QN}q_{Nt} + \beta_{WREL}w_{RELt} = 0$
with the *a priori* restriction $\beta_{PREL} = -\beta_{QN} = 1 = \beta_{PQN}$.

	STANDARD BS				EXTENDED BS				
	Cointegration +/-	Values of β_{PREL}	β_{QT}	β_{QN}	Cointegration +/-	Values of β_{PREL}	β_{QT}	β_{QN}	β_{WREL}
GERMANY	+	1	1.32	1	+	1	1.32	1	0
FRANCE	+	1	.82	1	+	1	1.00	1	.23
ITALY	+	1	.51	1	+	1	1.00	1	.81
SPAIN	+	1	1.60	1	+	1	1.46	1	0
NETHERL	-	N.A.			+	1	1.00	1	.78
BELGIUM	+	1	1.00	1	+	1	1.00	1	0
AUSTRIA	+	1	.51	1	N.A	N.A.			
FINLAND	+	1	.87	1	+	1	1.00	1	.18

Memorandum item: For Austria, the extended BS model could not be estimated because sectoral wage data was not available. Results according to the standard BS model are not reported for the Netherlands because of rejection on cointegration. Lower case letters refer to variables in logs. $p_{REL}=p_N-p_T$ where p_i is the GDP deflator in sector i, $i = T, N$ where T refers to the traded goods sector and N to the non-traded goods sector. q^i= labour productivity. $w_{REL} = w_T - w_N$ where w_i is the sectoral production wage. When testing the standard BS model, the H_0-hypothesis is rejected in all countries other than Germany, Spain and Belgium. In Germany and Spain, the magnitude of β_{QT} is larger than unity in a free estimation. In Belgium, the free estimate is .9 which, however, does not differ significantly from unity. In the five other countries, the standard Balassa-Samuelson model is rejected. This also suggests that there are important behavioural differences between the countries examined.

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5.2 Testing long-run homogeneity of the sectoral wages

As the standard Balassa-Samuelson model -- which is theoretically well-grounded, with plenty of empirical literature endorsing its relevancy -- did not find support in five countries (France, Italy, Austria, Netherlands or Finland), an explanation is in order.

Graphical analysis above suggested that the common presumption of the BS model -- the assumption of uniform wage paths in the traded goods sector and in the non-traded goods sector -- may contradict the data. We now proceed by testing the matter more formally.

Uniformity of sectoral wages in the long run implies that the relative wage, $w_{REL}=w_T-w_N$, is stationary. Since sectoral wages are non-stationary, this requires that they must be cointegrated with a cointegration vector *[1 -1]*. To test this hypothesis, we estimate the two dimensional VAR

$$\beta_{WT}w_{Tt} + \beta_{WN}w_{Nt} + \varepsilon_t = 0 \qquad (12)$$

and test for cointegration and the hypothesis

H_0: $\beta_{WT} = -\beta_{WN} = 1$.

by restricting the parameter in the model. If cointegration is found and the H_0-hypothesis is in accordance with the data, it is appropriate to conclude that sectoral wages follow a uniform path.

Estimation and results

Results of residual analysis were generally satisfactory. In spite of this, excess kurtosis in some countries needed to be controlled by dummies[16].

The results of the estimation appear in detail in Table A2 in the Appendix, in which the parameter β_{WN} is restricted to -1, and the unrestricted model appear. Cointegration was found in all cases considered implying $r=1$. However, the H_0-hypothesis of an elasticity of unity was rejected in every country but Belgium. The parameter β_{WN} was smaller than unity in France and Italy and larger in the rest of the countries.

For Germany, we also tested whether the value of β_{WN} would change if the unification period were left out. It turned out, however, that the results of an estimation which ends in 1989 were almost identical to those with full observation period. This indicates that unification did not have a first-order impact on developments in sectoral relative wages. Furthermore, we examined whether the results for Finland change if the recession years of the 1990's are skipped. A regression with an estimation period which ends at 1990 did not support this conjecture.

Results for the Netherlands have to be considered with particular caution.

[16] In Germany the relevant dummy relates to 1970 and in Italy to 1972. As in the earlier estimations, 1991 which was the first year of the severe depression in Finland needs to be controlled.

This is because the hypothesis β_{WN}=-1 passes but so also does the hypothesis β_{WN}=0. This indicates that β_{WN} is very imprecisely defined. Furthermore, the Trace test gave no strong support for cointegration of the two wage series and neither did evaluation of the common trends[17]. However, the error correction property showed up more strongly when β_{WN} was given a value which is larger than unity.

So, we conclude that the hypothesis of uniform sectoral wage paths is rejected throughout -- except in Belgium. As this implies that a key assumption of the standard Balassa-Samuelson model violates the data in most countries, an extension of the empirical model is suggested in order to take this caveat into account.

5.3 The *extended* Balassa-Samuelson model

Estimations above rejected the *standard* Balassa-Samuelson hypothesis in most countries. In addition, the assumption of uniform wage development underlying the BS model turned out to be generally inappropriate. Therefore, in the present Section, we examine the *extended* BS model as defined in Section 2 above.

Let us consider a model with relative prices, relative productivities and relative wages as expressed in (4) above. Incorporating the relevant productivity measure, q_i, the equation looks like:

$$\Delta p_{REL}=\Delta p_N-\Delta p_T=(\gamma/\theta)\Delta q_T-\Delta q_N-\gamma(\Delta w_T-\Delta w_N) \qquad (4')$$

[17] A possible reason for this may be as follows. In the Netherlands, the share of part-time work is exceptionally high. Its role started to increase in the 1980's. Since part-time work is more common in services and it implies that the annual average wage per head is lower, we are inclined to argue that the trend increase in the importance of part-time work is a potential reason for problems related to estimations with the Dutch data.

Normalizing with respect to $(p_{REL}+q_{N})$, *(4')* defines the following empirical long-run relationship:

$$(p_{RELt}+q_{Nt}) - \beta_{QT}q_{Tt} + \beta_{WREL}w_{RELt} + \varepsilon_t = 0 \qquad (13)$$

where $w_{REL}=w_T-w_N$. In this model, the dynamic adjustment equation for $(p_{RELt}+q_{Nt})$ is -- assuming two lags in levels -- given by:

$$\begin{aligned}\Delta\ (p_{RELt}+q_{Nt})_t = \ & \textit{possible constant} + \textit{possible dummies} \\ & + \eta_1\Delta q_{Tt} + \eta_2\Delta w_{RELt} + \eta_3\Delta\ (p_{RELt}+q_{Nt})_{t-1}+\eta_4\Delta q_{Tt-1}+\eta_5 w_{REL,t-1} \qquad (14) \\ & + \alpha[\ (p_{REL}+q_N)+\beta_{QT}q^T+\beta_{WREL}w_{REL}]_{t-1} + \nu_t\end{aligned}$$

As in Section 5.1 above, (4') and (13) imply that the "economic identification" related to the model is only achieved when β_{QT} is larger than or equal to unity. Furthermore, the theoretical model implies $0< \beta_{WREL} <1$ must hold. This is an additional condition for "economic identification".

Below we proceed as follows. First, cointegration is tested. If it is not rejected, we consider whether one or more of the variables could be considered as weakly exogenous. This implies that the related α-coefficient does not differ significantly from zero. In the resulting conditional model, the value of β_{QT} is examined. Two cases are possible. If the point estimate of β_{QT} is larger than unity, the extended model is not rejected. If, however, the free estimate of β_{QT} is smaller than one, we test whether it differs significantly from unity. The related H_0- hypothesis is

H_0: $\beta_{QT} \geq 1$.

After having examined H_0, we consider more thoroughly the role of relative wages. In particular, we impose and test the restriction

$$H'_0: \beta_{WREL} = 0 .$$

If not rejected, H'_0 implies that relative wages do not affect equilibrium in the long run[18]. If H'_0 is rejected, β_{WREL} should be smaller than unity.

The extended BS model is the appropriate description of the data if cointegration exists with $\beta_{QT} \geq 1$ and $0 < \beta_{WREL} < 1$. The specification collapses to the *standard* BS model -- with no relative wages in the long-run relationship -- if cointegration is found with $\beta_{QT} \geq 1$ and $\beta_{WREL} = 0$.

Estimation and results

Although results of residual analysis in the three dimensional model were generally encouraging, certain dummies were needed to control for excess kurtosis[19]. As before, misspecification tests indicate that we do not lose anything by restricting the lag length to either 2 or 3.

If there is cointegration, we expect one well-specified relationship to show up. However, as the tests sometimes (France, Italy, Belgium and the

[18] This would still allow the relative wage to play a role in the short-run adjustment, which contrasts with the standard BS specification. The short run part of the dynamic equation related to the *restricted* extended BS model is different from the standard BS equation as can be observed by comparing equations (11) and (14) above.

[19] In Germany the relevant dummy relates to price movements in 1968. In Finland, the recession dummy enters in 1991. In France, a dummy in 1988 is due to the sudden jump in the traded goods sector productivity. Results for Belgium must be considered with particular caution because cointegration in the model is uncertain and two dummies were needed to control for outliers in residuals in 1986 and 1993.

Netherlands) indicate that there is another long-run relationship in the data space, we have an additional vector to consider. The choice of the adequate rank is of great importance due to the small sample problems discussed above. Choosing a "too high" r implies that the tests imposed are "too loose". On the other hand, if the correct choice is, for example, r = 2 but we choose r = 1, the tests are excessively stringent and the resulting p-values are definitely the lower limits of the appropriate ones. Whether the "last" eigenvector contains relevant information about the long-run relationship of interest can also be evaluated by comparing the parameter estimates discovered including and excluding this vector.

In a few cases, the suggestions of different test procedures on r -- whether r is 1 or 2 -- were not uniform. In particular, this was the case of Belgium and Spain. We conclude, however, that it is more probable that r=2 in Belgium and r=1 in Spain. For the rest of the countries, we conclude that r=1 in Germany and Finland and r=2 in France, Italy and the Netherlands[20].

The results related to this model are in Table A3. There are two columns for each country, *A* and *B*. Column *A* reports the free estimation for countries in which the result gives a value for β_{QT} larger than unity (Germany and Spain), and, for countries where the free estimate of the β_{QT} was less than unity, it reports results of an estimation in which the precondition for economic

[20] Three examples of the inference are as follows. In Spain, the Trace test suggested that r=2. At the outset, so did also evaluation of the roots of the companion matrix; one of the roots was very close to unity and the second root was clearly smaller. After having imposed data consistent restrictions we noticed that the second root had drifted to unity. Therefore, final tests were carried out under the assumption that r=1. In Germany, the Trace test suggested that r=1 whereas examination of the roots of the companion matrix indicated that r=2. In this case we started by assuming that r=2 but, again, noticed that when restrictions had been imposed, another root had drifted towards unity. Therefore, the reported tests were carried out under the assumption that r=1. In the Netherlands the case was unclear at the outset; one of the roots was slightly outside the unit circle. After having chosen r=2 and after having imposed restrictions present in the preferred equation in Table A3, we noticed that the largest root was unity and the second largest was considerably smaller. This indicates that r=2 is indeed the right choice.

identification (β_{QT}=1) has been imposed[21]. Column *B* is a test on the significance of the relative wage in the long-run relationship. The preferred cointegrating vector is marked with a star (*) in the Table.

In a free estimation $\beta_{QT} \geq 1$ holds for Germany and Spain. Furthermore, H_0 which restricts β_{QT} to unity could not be rejected in any of the remaining countries. This indicates that the presence of relative wages in the cointegrating relationship helps the productivity hypothesis incorporated in the BS model to survive in every single country.

The final test relates to exclusion of the wage variable from the long-run relationship. According to the LR test, omission is valid only in Germany, Spain and Belgium. This result comes as no surprise since these are the three countries where the *standard* BS was shown to be appropriate in Section 5.1 above. Furthermore, Belgium is the only country where sectoral wages were found to be cointegrated with a coefficient of unity.

In all other countries -- France, Italy, Netherlands and Finland -- relative wage behaviour incorporates additional information which is relevant for the long-run data generating process related to the development of relative prices. Furthermore, the second condition for "economic identification", i.e $0 < \beta_{WREL} < 1$, is satisfied in all relevant cases.

The final comment relates to our productivity measure. As discussed

[21] As far as estimations reported in Table A3 are concerned, a clarification is in order. This relates to what is a "free" and what is a "restricted" estimation in different countries. In most countries we concluded that r=1. This implies that one single restiction is binding. In France, Italy and the Netherlands we concluded, however, that there are two cointegrating vectors, r=2. Therefore, the cointegration vector can also be a linear combination of the two vectors. By imposing a restriction according to the H_0-hypothesis, we can restructure the data. In the context of France, the hypothesis that the restriction implies nothing more than restructuring can be scrutinized by testing whether a "pre-known" vector [1, 1, -.23] is in the data space. The hypothesis is not rejected and the relevant p-value is 1.00. So, when r=2, one restriction is not binding and, for the countries concerned, the first estimation is characterized as "free" in Table A3. When adding the second restriction related to the wage variable, the estimation is "restricted" also when r=2.

above, we have measured labour productivity as output per head rather than as output per hour. This could generate problems particularly when part-time work becomes more common. On the other hand, if pay declines with hours the relationship between our productivity measure and price setting does not necessarily change. This also concerns the standard model. If pay does not change, the potential bias is "corrected" in the extended BS set-up because wages are also measured per head. Comparison of the results for the Netherlands in Sections 5.1 and 5.3 supports this interpretation. As it happens, our qualitative judgements about the basic features of the "right" specification are generally identical in the extended and standard models. This indicates that the inference on dual inflation is not necessarily sensitive to the way of measuring labour productivity.

5.4 Conclusions of the econometric analysis

-The "standard" Balassa-Samuelson model finds support in Germany, Spain and Belgium. However, in France, Italy, Netherlands, Austria and Finland it is not an appropriate description of the relationship between relative prices and productivities.

-Wages in the tradable goods sector and in the non-tradable goods sector are cointegrated but do not follow a uniform path -- with Belgium as the only exception.

-In a model including relative wages, prices and productivities, cointegration is found throughout, although in the Netherlands with a few question marks. Consistently with our earlier results, the standard Balassa-Samuelson model is in accordance with the data in Germany, Spain and Belgium. In the rest of the countries relative wages do contain crucial additional information about the data generating process concerned in the long run.

-As far as interaction of sectoral prices, wages and productivities is concerned, there seem to be fundamental differences between countries. If that is the case, it may be inappropriate to use estimation methods which -- as result of pooling of the data -- produce identical parameter estimates for all countries.

-For all the countries concerned, we have found plausible long-run relationships which describe the generation of the dual inflation. These relationships have two important implications. First, dual productivity growth has been an important source of dual inflation in every country. Secondly, in many countries relative wages have played a crucial additional role.

Our results emphasise the implication of two competing modelling strategies. On the one hand, although the *standard* Balassa-Samuelson model in 5.1 is a well-grounded set-up, it is fairly restrictive. In particular, it abstracts away any role of relative wages both in the short and in the long run. On the other hand, the *extended* BS model nests the standard model. In this particular meaning, it allows the "general-to-specific" estimation strategy to be applied. This strategy starts with a more general specification and tests whether it is appropriate to arrive at more parsimonious empirical specifications.

In our view, the second strategy is superior to the former which is usually followed in the papers studying the Balassa-Samuelson hypothesis. Although cointegration is found both in the *standard* and *extended* specifications, the likelihood ratio test indicates that the former model is generally a mispecified one because it does not include relative wages. This missing variable turns out to be crucial to rescue the BS productivity hypothesis in many countries.

6. SIMULATIONS

This section considers the implications of the above results for potential inflation differentials in EMU. In the simulations below, all assumptions about numbers either refer to actual growth rates in the historical data or apply estimated parameters resulting from the cointegration analysis above.

Since the *extended* BS model is endorsed by the data, our baseline simulation is based on it. However, we also report in the appendix simulations according to the *standard* BS model. They act as a set of control solutions and allow us to compare the two models in practice. In simulations, we assume throughout that an ECB inflation target (2% p.a) for the EMU-area is met.

In order to set the framework for simulations, let us consider the empirical counterpart of equation (5) in Section 2 which represents the extended BS model for the relationship between relative productivities, prices and wages with subscript j refering to each of the eight countries under consideration:

$$\Delta p_{RELj}=\Delta p_{Nj} -\Delta p_{Tj} = \beta_{QTj}\Delta q_{Tj}-\Delta q_{Nj}-\beta_{WRELj}(\Delta w_{Tj}-\Delta w_{Nj}) \qquad (5')$$

where β_{QTj} and β_{WRELj} correspond to the estimated cointegration parameters.

According to (7), national inflation is a weighted average of sectoral inflation rates

$$\Delta p_j=(1-\delta_j)\Delta p_{Tj}+\delta_j\Delta p_{Nj} \qquad (7')$$

where δ_j is the share of non-tradables in consumption. The aggregate inflation in EMU is a weighted average of the member countries' inflation rates, and the weights are the GDP shares, ρ_j:

$$\Delta p_{EMU}=\sum\rho_j \ \Delta p_j \qquad (15)$$

Solving (5') for Δp_{Nj} , substituting it into (7') and the resulting expressions for national inflation into (15) we obtain the following expression for EMU inflation:

$$\Delta p_{EMU}=\sum\rho_j[\Delta p_{Tj}+\delta_j(\beta_{QTj}\ \Delta q_{Tj}\ -\Delta q_{Nj}-\beta_{WRELj}(\Delta w_{Tj}-\Delta w_{Nj}))] \tag{16}$$

Finally, assuming without loss of generality that PPP holds in the tradable sector so that $\Delta p_{Tj}=\Delta p_T$ in every country, the expression simplifies to:

$$\Delta p_{EMU}=\Delta p_T + \sum\rho_j\delta_j[\beta_{Tj}\ \Delta q_{Tj}-\Delta q_{Nj}-\beta_{Wj}(\Delta w_{Tj}-\Delta w_{Nj})] \tag{17}$$

These expressions are the basis for the simulation exercises. The parameters are chosen as follows. ρ_j is the actual share of each country's GDP in EMU; the share of non-tradables (δ_j) is computed from the data set. Growth in tradable and non-tradable productivity and wages $(q_{Tj},\ q_{Nj},\ w_{Tj},\ w_{Nj})$ are their historical averages. Finally, each β_{Tj} and β_{WRELj} corresponds to the long-run cointegration parameters in Table 2. The only unknown in (17) is Δp_T, since Δp_{EMU} has been set equal to 2%, so we solve for it. Then, non-tradable inflation Δp_{Nj} is obtained from (5'). After that, national inflation rates are defined by (7').

The results of the exercise appear in Table 3. In computations, we have used average growth rates which refer to three different sample periods, defined at the top of the table. First, averages for the whole sample for each country were used. This is, however, somewhat arbitrary because the observation period varies considerably from country to country. Second, we used data for the post-1975 period. Third, the right hand side column in Table 3 applies to more recent observations for the post-1985 period.

As far as the projected inflation rates are concerned, there are sizeable but not dramatic differences between countries. Since the tradable goods inflation is common, these inflation differentials are entirely due to divergences in the non-tradable goods inflation. The latter is higher than the former without exception.

When full-sample data is used in this extended BS set-up, inflation ranges from around 1.1% (Finland) to around 3.6% (Spain). When the longest sample common to all countries (post-1975 period) is applied, Germany has the lowest (1.3%) and Belgium the highest (3.1%) inflation. Finally, in a projection based on the post-1985 period, Germany has the lowest (1.3%) inflation and Spain the highest (3.5%).

To sum up, Germany, France and Austria are consistenly below the average inflation, while Spain, Italy and Belgium are above the average. Finland shifts depending on the period due to two reasons. First, severe economic instability in the 1990s after the collapse of the Soviet Union plays an important role in the post-1985 period. Second, in the latter half of the 1970s considerable wage compression resulting from trade union actions generated exceptional inflation pressures which dominate in simulations based on post-1975 data.

For completeness and comparison, simulations according to the *standard* BS model were run despite the fact that this model was rejected by the data in most countries. In this exercise we assume that relative wages play no role and use the parameter values according to the *standard* BS model which appear in the first column of Table 2. The results of this excercise appear in Table A4 in the Appendix. With Spain and the Netherlands as two exceptions, differences in the country-specific inflation predictions are not very large in the two exercises according to the two competing model specifications[22]

Table 3

[22] Austria and Belgium cannot be considered in this comparison. In the former, there are no data on relative wages. In the latter, relative wages are stationary. When the two tables are compared, inflation varies in these countries simply because tradable goods inflation for the whole area is different. In France, wages in the non-tradable goods sector have tended to rise slightly faster. On the other hand, after having introduced relative wages into the extended BS model, the cointegration parameter β_{QT} increased (see Table A1 and A3). The final result is a slight reduction in the French inflation projection. In Italy, where the non-tradable sector's wages seem to have grown faster as well, we do not observe this effect. This is probably because the magnitude of the β_{WREL}-coefficient in Table A3 is considerably larger in Italy than in France.

Simulated annual inflation rates, %, in the country concerned, according to the "extended" Balassa-Samuelson model:

$$\Delta p_{RELj} = \beta_{QTj}\Delta q_{Tj} - \Delta q_{Nj} - \beta_{WRELj}\Delta(w_{Tj}-w_{Nj})$$

	share	Full sample		post-1975		post-1985	
	δ	Δp	Δp_N	Δp	Δp_N	Δp	Δp_N
GERMANY	.62	1.7	2.5	**1.3**	1.7	**1.3**	1.8
FRANCE	.69	1.5	2.1	1.7	2.3	1.6	2.1
ITALY	.68	2.0	2.8	2.4	3.2	2.4	3.3
SPAIN	.68	**3.6**	5.1	3.1	4.3	**3.5**	4.8
NETHERLANDS	.72	2.1	2.7	2.3	2.9	2.1	2.8
BELGIUM	.69	3.1	4.4	**3.1**	4.3	2.7	3.6
AUSTRIA	.69	1.5	2.0	1.8	2.4	1.5	2.0
FINLAND	.62	**1.1**	1.6	2.4	3.6	1.5	2.1
EMU		**2.0**	**2.8**	**2.0**	**2.7**	**2.0**	**2.7**
		Δp_T = 0.4		**Δp_T = 0.5**		**Δp_T = 0.5**	

Memorandum item: In this exercise, relative productivities and relative wages have been assumed to move as they have done within the period defined at the head of each column. δ, the share of non-tradables is according to the average of the last period. Values of the β-coefficients come from the estimations reported in the Tables. The lowest and highest inflation rates are in bold. The traded goods inflation, Δp_T, is restricted to be identical in all countries which indicates that *the law of one price* holds for traded goods.

7. CONCLUSIONS

This paper has explored the productivity hypothesis and its potential implications for inflation differentials in EMU. The empirical examination has been based on cointegration analysis of data on relative prices, relative productivities and relative wages. The traditional or "standard" BS hypothesis establishes a well-defined negative relationship between sectoral inflation differentials and relative productivities. That theoretical set-up, however, requires that wage development is uniform in the traded goods sector and in the non-traded goods sector.

We first test and reject the standard BS hypothesis in five out of eight countries for which data is available. The countries in which the standard BS model passes are Germany, Spain and Belgium. Although relative prices and productivities are generally cointegrated and the relationship is negative, in most cases the cointegrating vector is different from what the theoretical model implies. On these occasions, "economic identification" is not achieved. Because a formal test suggests that relative wages are not stationary and that sectoral wage paths are not uniform, the BS model was extended by allowing relative wages to enter. It turns out that relative prices, productivities and wages are cointegrated with the expected signs and, furthermore, country-specific cointegration vectors are in full accordance with the theoretical priors. Thus, the extended BS model appears to be well well in accordance with the data.

In our view, this is an important result for two reasons. First, the divergent behaviour of sectoral nominal wages has, as far as we are aware, not been addressed in the literature on real exchange rates so far. Secondly, the fact that the BS hypothesis generally holds only when taking into account relative wages may shed new light on the underlying sources of inflation differentials.

The original writings by Balassa and Samuelson explained inflation differentials by real convergence between countries. In their neoclassical, full-employment context, inflation differentials do not entail loss of competitiveness and indeed they may actually be interpreted as benign since the underlying shifts in relative prices should improve resource allocation. However, a less benevolent interpretation of inflation differentials in monetary unions seems to adapt better to the situation of high unemployment in Europe, caused by market rigidities.

Labour and product market real rigidities lead not only to sectoral productivity differentials but also to losses in competitiveness which, in a monetary union, cannot be corrected by a currency devaluation. It follows then, that the adjustment is born by real variables. Actually, it is assumed in the model that traded- goods inflation is common in all countries. This does not necessarily mean that there are no competitiveness problems due to dual inflation. On the one hand, non-traded goods are an important cost component for the traded good sector. On the other hand, higher non-traded goods (service-sector) inflation may generate wage pressures which affect both sectors. Therefore, competitiveness problems may actually exist although they will not show up in the *ex post* data. This happens when, for example, firms adjust their workforce or capacity in order to maintain competitiveness, that is, to satisfy PPP. This also happens when non-competitive firms go bankrupt and, as a consequence, the average competitiveness of the prevailing enterprises rise.

The relative importance of rigidities in the behaviour of sectoral productivity is not easy to identify and, in any case it falls beyond the scope of this paper, but the rejection of wage homogeneity shows that the traditional BS hypothesis does not hold. Thus, the tentative conclusion is that they are surely relevant. Thus, in EMU, the PPP condition may imply costly real adjustments in terms of output and unemployment.

The paper contains a simulation exercise based on the empirical analysis. It allows us to give a positive, although qualified, answer to the question posed in the title of the paper. Inflation differentials, due to productivity differentials, may well emerge in EMU. The difference between the high-inflation countries and low-inflation countries may reach around 2 percentage points in annual terms. Because tradables inflation has been assumed to be common in all countries, these differentials fully reflect differences in the non-traded goods inflation in the countries concerned.

Despite the results of the exercise, inflation differentials should not be taken for granted. The exercise extrapolates past trends, that is, it assumes that EMU will have no effect on the adjustment mechanisms. However, EMU will mean more competition both in the tradable and in the non-tradable sector. This will surely have an impact on sectoral productivity, in particular if the underlying source of productivity differencials are rigidities. The absence of the nominal exchange rate as potential adjustment mechanism presumably influences expectation formation. Because of this, the behaviour of agents and markets can hardly remain unchanged because it will be acknowledge that wage pressures and inefficient behaviour will have a larger real costs. All this means that our results should be seen as an upper bound to inflation differentials in EMU.

The normative judgements on our results depend again on the underlying sources of inflation differentials. If, as it is suspected, rigidities play a relevant role in the existence of inflation differentials after EMU two suggestions for the economic policy follow. First, governments can reduce problems related to inflation differentials by enhancing productivity growth in the non-traded goods sector. Secondly, governments should pursue structural policy (related to the functioning of the labour market) which loosens sectoral wage-wage linkages and reduces inflation pressures generated by excessive wage claims particularly in the non-traded goods sector. Both measures would allow a better position to face the new competitive environment.

All in all, our work should be taken as a warning that inflation differentials may persist in EMU, due to real factors and market rigidities. The consequences of these differentials for the management of the monetary union are difficult to envisage beforehand, but the clear mandate for the ECB to maintain price stability for the whole area should be a safeguard against these risks[23].

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Appendix

Table A1

Cointegrating relationships[a] between relative prices and productivity levels in the traded goods sector and the non-traded goods sector in model

$\beta_{PREL} p_{REL} + \beta_{QT} q_T + \beta_{QN} q_N = 0$, with the *a priori* restriction $\beta_{PREL} = -\beta_{QN} = 1 = \beta_{PQN}$.

		GERMANY		FRANCE		ITALY		SPAIN		NETHERLAND	BELGIUM		AUSTRIA		FINLAND	
Type of estimation		FREE*	REST	FREE	REST*	FREE	REST*	FREE*	REST		FREE	REST*	FREE	REST*	FREE	REST*
Cointegration rank		r=1	r=1	r = 1	r =1	r = 1	r =1	r = 1	r=1	r=0	r=1	r=1	r=1	r=1	r=1	r =1
coefficients	variables	*long run coefficients β_i*														
β_{PQN}	$p_{REL}-q_N$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	No cointeg ation	1.00	1.00	1.00	1.00	1.00	1.00
β_{QT}	q_T	1.26	1.00	0.82	1.00	0.51	1.00	1.60	1.00		0.91	1.00	0.51	1.00	0.87	1.00
		adjustment coefficients α_i														
α_{PQN}	$\Delta(p_{REL}-q_N)$	.00	.00	-.55	-.21	-.28	-.07	.00	.00		.00	.00	-.30	.13	.00	.00
				(3.78)	(1.65)	(4.48)	(2.29)						(3.72)	(1.51)		
α_{QT}	Δq_T	-.42	-.08	.00	.00	.00	.00	-.24	-.03		-.38	-.29	.00	.00	-.84	-.64
		(-3.23)	(.51)					(6.41)	(.29)		(6.21)	(5.67)			(8.02)	(3.26)
		restrictions														
restriction imposed			$\beta_{PQN}=\beta_{Q}$		$\beta_{PQN}=\beta_{Q}$		β		$\beta_{PQN}=\beta_{QT}$			$\beta_{PQN}=\beta_{QT}$				$\beta_{PQN}=\beta_{QT}$
LR-test statistic ~ $\chi^2(1)$			8.33		7.85		9.68		24.5			2.15		7.99		20.84
p-value			.00		.01		.00		0.00			0.14		0.00		0.00
Estimation period		1963-93		1977-92		1972-95		1965-93		1977-95	1975-94				1976-95	

[a] All variables are in logs. The subindices N,T refer to non-traded and traded sectors, respectively. $p_{REL}=p_N-p_T$ is the relative prices. q_T,q_N are the sectoral level of productivity. The star in the second row indicates the preferred specification. Below the α-coefficients are the t-statistics. When the preliminary analysis indicated that some α does not differ significantly from zero, the variable was considered as weakly exogenous. In the table these α-coefficients have been underlined. The critical value, at 5% level, of $\chi^2(1)$ is 3.84. Higher values allow rejection of the null hypothesis.

Table A2

Cointegrating relationships[a] between wage levels in the traded goods sector and the non-traded goods sector under cointegration rank, r=1 .

		GERMANY	FRANCE	ITALY	SPAIN	NETHERLA	BELGIUM	AUSTRIA	FINLAND
Type of estimation		REST	REST	REST	REST	REST	REST	N.A	REST
Cointegration rank		r=1	r = 1	r =1	r=1	r=1	r=1		r =1
coefficients	variables	*long run coefficients β_i*							
β_{WT}	w^T	1.00	1.00	1.00	1.00	1.00	1.00		1.00
β_{WN}	w_T	-1.00	-1.00	-1.00	-1.00	-1.00	-1.00		-1.00
		adjustment coefficients α_i							
α_{WT}	Δw_T	-.12	-.05	-.29	-.05	<u>.00</u>	-.10		-.04
		(-4.86)	(.42)	(-5.04)	(-.61)		(-1.89)		(-1.04)
α_{WN}	Δw_T	-.19	.02	-.39	-.06	-.05	-.07		-.04
		(-5.73)	(.18)	(-4.61)	(-.48)	(-1.90)	(-.73)		(-.48)
		restrictions							
restriction imposed		β_{WT}=-β_{WN}	β_{WT}=-β_{WN}	β_{WT}=-β_{WN}	β_{WT}=-β_{WN}	β_{WT}=-β_{WN}	β_{WT}=-β_{WN}		β_{WT}=-β_{WN}
LR-test statistic ~ $\chi^2(1)$		14.97	16.63	17.21	12.44	0.05	8.65		16.75
p-value		.00	.00	.00	0.00	.99	0.00		.00
Estimation period		1963-93	1977-92	1970-95	1965-93	1977-95	1975-94	1976-95	1972-95

[a] All variables are in logs. The subindices N,T refer to non-traded and traded sectors, respectively. w_N, w_T are the sectoral labour cost. Below the α-coefficients are the t-statistics. When the preliminary analysis indicated that some α does not differ significantly from zero, the variable was considered as weakly exogenous. In the table these α-coefficients have been underlined. The critical value, at 5% level, of $\chi^2(1)$ is 3.84. Higher values allow rejection of the null hypothesis.

Table A3

Cointegrating relationships between relative prices, productivity levels and relative wages in the traded goods sector and the non-traded goods sector in model

$$\beta_{PREL}p^{REL}_t - \beta_{QT}q^T_t + \beta_{QN}q^N_t + \beta_{WREL}w^{REL}_t = 0$$,with the *a priori* restriction $\beta_{PREL} = -\beta_{QN} = \beta_{PQN} 1$

		GERMANY		FRANCE		ITALY		SPAIN		NETHERLANDS		BELGIU	AUSTRI	FINLAND	
Type of estimation		A	B*	A*	B	A*	B	A	B*	A*	B	A	-	A*	B
Cointegration rank		r=1	r=1	r = 2	r = 2	r = 2	r = 2	r = 1	r = 1	r = 2	r = 2	r = 2		r=1	r=1
coeff.	variables	*long run coefficients* β_i													
β_{PQN}	$p_{REL}-q_N$	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	No wage	1.00	1.00
β_{QT}	q_T	1.44	1.32	1.00	1.00	1.00	1.57	1.81	1.57	1.00	1.00	1.00	wage	1.00	1.00
β_{WREL}	w_{REL}	0.34	0.00	0.23	0.00	0.81	0.00	0.40	0.00	0.78	0.00	0.00	data	0.18	0.00
		adjustment coefficients α_i													
α_{PQN}	$\Delta(p_{REL}-q_N)$	.00	.00	.038	.26	-.16	-.01	.00	.00	.41	.25	.12		.00	.00
				(0.13)	(1.21)	(4.76)	(0.17)			(1.44)	(2.37)	(1.12)			
α_{QT}	Δq_T	-.32	-.22	-.69	-.38	.00	.00	-.20	.24	-.54	-.17	-.42		-1.34	-.88
		(-4.83)	(2.76)	(-5.5)	(4.23)			(-6.74)	(6.24)	(2.76)	(2.21)	(-35.0)		(-12.0)	(4.33)
α_{WREL}	Δw_{REL}	.00	.00	.00	.00	-.13	-.05	.00	.00	.00	.00	-.03		.00	.00
						(-5.42)	(-1.70)					(-.85)			
		restrictions													
restrictions imposed			$\beta_{WREL}=0$	$\beta_{PQN}=\beta_{QT}$	$\beta_{WREL}=0$, $\beta_{PQN}=\beta_{QT}$	$\beta_{PQN}=\beta_{QT}$	$\beta_{WREL}=0$, $\beta_{PQN}=\beta_{QT}$		$\beta_{WREL}=0$	$\beta_{PQN}=\beta_{QT}$	$\beta_{WREL}=0$, $\beta_{PQN}=\beta_{QT}$	$\beta_{WREL}=0$, $\beta_{PQN}=\beta_{QT}$		$\beta_{PQN}=\beta_{QT}$	$\beta_{WREL}=0$, $\beta_{PQN}=\beta_{QT}$
LR-test statistic $\sim \chi^2(1)$					2.66		4.84		6.85		2.44	.01		2.44	32.38
p-value			.40		.03		.03		0.12		.06	.94		.12	.00
Estimation period		1963-93		1977-92		1972-95		1965-93		1977-95		1975-94		1971-95	

[*] All variables are in logs. The subindices N,T refer to non-traded and traded sectors, respectively. $p_{REL}=p_N-p_T$ is the relative prices. q_T, q_N are the sectoral level of productivity and w_N, w_T are the sectoral labour costs. The star in the second row indicates the preferred specification. Below the α-coefficients are the t-statistics. When the preliminary analysis indicated that some α does not differ significantly from zero, the variable was considered as weakly exogenous. In the table these α-coefficients have been underlined. The critical value, at 5% level, of $\chi^2(1)$ is 3.84. Higher values allow rejection of the null hypothesis.

Table A4

Simulated annual inflation rates, %, in the country concerned, according to the "standard" Balassa-Samuelson model:

$$\Delta p_{RELj} = \beta_{QTj}\Delta q_{Tj} - \Delta q_{Nj}$$

	share	Full sample		post-1975		post-1985-end	
	δ	Δp	Δp_N	Δp	Δp_N	Δp	Δp_N
GERMANY	.62	1.8	2.6	**1.4**	1.8	1.5	1.9
FRANCE	.69	1.6	2.1	1.8	2.2	1.6	2.1
ITALY	.68	2.3	3.1	2.6	3.4	2.7	3.6
SPAIN	.68	2.7	3.7	2.4	3.2	2.7	3.7
NETHER	.72	1.5	1.9	1.7	2.0	1.6	1.9
BELGIUM	.69	**3.4**	4.7	**3.3**	4.5	**2.9**	3.9
AUSTRIA	.69	1.7	2.3	2.01	2.6	1.8	2.2
FINLAND	.72	**1.0**	1.2	2.3	3.3	**1.4**	1.8
EMU		**2.0**	**2.7**	**2.0**	**2.6**	**2.0**	**2.6**
		Δp_T = 0.6		**Δp_T = 0.7**		**Δp_T = 0.8**	

Memorandum item: In this exercise, relative productivities and relative wages have been assumed to move as they have done within the period defined at the head of each column. δ, the share of non-tradables in consumption takes the average values of last periods. Values of the β-coefficients come from the estimations reported in the Tables. The lowest and highest inflation rates are in bold. The traded goods inflation, Δp_T, is restricted to be identical in all countries which indicates that *the law of one price* holds for traded goods.

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