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Abstract

In this paper we present some descriptive evidence and simulation exercises with both an estimated backward looking model and a calibrated general equilibrium forward looking model that allow some light to be shed on the determinants and macroeconomic implications of persistent inflation differentials in Spain within EMU. We show that a demand expansion biased towards consumption of non-tradable goods and real-wage rigidities –such as wage indexation clauses– are among the key determinants of diverging price developments in Spain. Moreover, we find that in those conditions the stabilising mechanism of terms of trade effects is relatively weak, although the economy undergoes lasting losses in competitiveness.

1 Introduction

From the very inception of EMU, the idea that a limited degree of dispersion of inflation rates across Member States is perfectly compatible with a soundly functioning monetary union has been accepted. Indeed, regional prices do not grow at the same rate in any of the currently estabished currency unions. This is the consequence of shocks not affecting all regional economies at the same time or with the same strength and/or the different way those shocks interact with the price formation mechanism prevailing in each region. Although the standard deviation of national inflation figures in EMU is currently somewhat larger than that of regional inflation rates in both the US and in euro area countries, a number of specific factors -of mostly a transitory nature- could help explain inflation dispersion in EMU since 1999. Those are mainly changes in administered prices and indirect taxation at the national level, discrepancies in the cyclical position of each economy or different exposure to external shocks (see ECB, 2003).

Therefore, the size of the dispersion of national inflation figures in the euro area does not seem a relevant specific feature of EMU. Yet, a more distinctive characteristic of price developments in the euro area which is now attracting much attention in the literature and in the policy debate is the persistence of those inflation differentials: countries with an inflation rate above or below average at a particular moment tend to remain in the same situation in the subsequent periods. By way of example, inflation in countries like Ireland, Portugal, Greece and Spain have consistently exceeded the EMU average while others like Germany and Austria have persistently remained below that reference.

In principle, persistent national inflation differentials need not be an adverse feature of a monetary union. As argued by Balassa (1964) and Samuelson (1964), this phenomenon can be associated with the process of real convergence of countries with lower income within the currency area. Those countries tend to experience high productivity growth in the tradable sector that would normally translate not only into higher real wages in that sector but also into higher nominal wages in the non-tradable sector that would imply higher aggregate price growth. There exists already some evidence that this effect can justify relatively sizeable inflation differentials (see Alberola and Ttyrväinen, 1998) in EMU. Moreover, differences in sectoral productivity growth seem to explain low-frequency movements in relative national price indices (see Ortega, 2003). But, based also on the latest evidence, there seems to be a growing consensus that the Balassa-Samuelson hypothesis cannot constitute a general explanation of persistent inflation differentials among EMU members (see e.g. Alberola, 2000, Rogers, 2002 and ECB, 2003).

An alternative hypothesis to that of Balassa-Samuelson is that persistent inflation differentials are caused by nominal and real rigidities affecting price and wage formation mechanism in combination with common or idiosyncratic shocks. This latter hypothesis has less benign normative implications than the former. As a very minimum, inflation differentials would in that case signal the likely presence of structural imperfections that reduce the overall efficiency of the economy and amplify the fluctuations of the business cycle. Moreover, those rigidities may cause persistent losses in competitiveness in high-inflation countries and increase the likelihood of potentially damaging deflationary episodes in low-inflation countries. From a more euro-wide perspective, persistent discrepancies of national inflation figures do pose an important communication challenge for monetary authorities and complicate the design of their optimal reaction function (see Benigno, 2003 and Benigno and López-Salido, 2002). Therefore, in order to identify the appropriate policy attitude towards inflation differentials it is important to characterise the specific factors that are causing diverging price developments.

Some recent literature provides information in that regard. Honohan and Lane (2003, 2004) argue with a simple regression analysis that much of the divergence on inflation rates among EMU countries is attributable to the differential impact of exchange rate movements. In contrast, Angeloni and Ehrmann (2004), making use of an estimated two-equation model for 12 euro area countries, obtain that inflation persistence -included as an ad-hoc extra-term in an otherwise standard New-Keynesian Phillips curve- is the single most relevant explanatory factor for persistent inflation dispersion. But in the last few years several papers have also made use of micro-founded models, in the tradition of Obstfeld and Rogoff (2000)'s new open economy macroeconomics, to explore more deeply the potential causes of inflation dispersion in a currency area. Depending on the specific features of the models employed, authors are able to emphasise a type of shock and/or a specific type of rigidity that help generate persistent price dispersion across the countries of a monetary union. For instance, Andrés et al. (2003) make use of a two-country model where all goods are tradable and price adjustment is costly to emphasise that price discrimination may actually generate substantial price dispersion in a monetary union. In a two-sector model also with price discrimination, Duarte and Wolman (2002) find that demand shocks are less likely to generate persistent differentials than supply shocks. By contrast, Altissimo et al. (2004), in a model with asymmetric price rigidities across countries and imperfect labour mobility across sectors, and where Purchasing Power Parity holds in the tradable sector, find that demand shocks -either aggregate or idiosyncratic- can more readily generate persistent inflation differentials than supply shocks.

Therefore, the available evidence does not yet offer a conclusive explanation of the factors underlying persistent inflation differentials in euro area countries. In fact, it seems unlikely that all discrepancies between national inflationary processes within EMU could be caused by the same factors. As an example, there should be little hope of finding a single argument that could completely explain both the positive inflation differential of Portugal -a low-growth, high-inflation country - and that of Ireland -a-high-growth, high inflation country-. In that regard, it may be worthwhile modifying the research focus. Instead of concentrating only on searching for a story that maximises the size or the persistence of inflation dispersion within the euro zone, we may gain from seeking the most likely determinants of the inflation differential of specific economies.

In this paper we try to follow this alternative approach by focusing on the case of Spain. We identify some stylised facts of Spanish economic developments over the last few years and investigate what could best explain its persistently positive inflation differential with the euro area average. We also try to understand better the adjustment mechanism of this economy within EMU and formulate some policy prescriptions. The analysis is conducted using a moderately eclectic methodological approach. Thus, we first employ some descriptive analysis and model simulations with a standard backward-looking macroeconometric model to obtain some preliminary empirical evidence on what type of developments seem to cause inflation and how the economy reacts to the relevant shocks. We then make use of a micro-founded two-country two-sector-model to understand better the structural characteristics of the economy that seem more closely associated with persistently positive inflation differentials. That model, taken from a companion paper (see López-Salido et al., 2004) incorporates, as a distinctive feature with respect to other models in this tradition, a richer specification of the wage formation process including both nominal wage rigidities and inflation indexation in order to better cope with some relevant aspects of the Spanish economy. Moreover, we assume that a fraction of economic agents have no access to the financial markets.

The rest of the paper is organised as follows. Section 2 provides some stylised facts on euro area inflation differentials, the potentially relevant features of the Spanish economy that characterise its price developments and the likely adjustment mechanisms that may have taken place. Building on that evidence, Section 3 presents a general equilibrium model and conducts simulations and sensitivity analysis to show the relevance of key structural parameters and fundamental shocks to explain the recent Spanish inflationary process. Finally, Section 4 offers some tentative policy conclusions.

2 Some facts and preliminary evidence

2.1 Inflation differentials in EMU

In ECB (2003) it is possible to find a comprehensive description of inflation differentials in EMU. The standard deviation of national inflation rates have fluctuated at around 1% over the last few years. This is in line with the dispersion of inflation rates among the 14 US Metropolitan Statistical Areas but significantly above that corresponding to German, Spanish or even US Census regions. In addition, unlike in other long-established currency unions, inflation differentials in EMU show a remarkable persistence. Several countries, like Ireland, Greece, Portugal, Spain and, until last year, the Netherlands have experienced annual inflation rates which have frequently exceeded the EMU average by more than 1 p.p.. By contrast, Austria and Germany, the largest euro area country, have systematically experienced a negative price growth differential with the EMU average which has often implied differences of inflation with other member countries of more than 2 p.p.

A first factor that might help explain persistent inflation differentials in EMU is the Balassa-Samuelson effect. This hypothesis requires national inflation rates to be positively correlated with the difference between labour productivity growth in the tradable sector and that in the non-tradable sector. Chart 2.1 explores this correlation by representing for all 12 EMU countries both average inflation and the average productivity growth differential between tradable goods (approximated by manufacturing) and non-tradable goods (approximated by market services). The chart shows an apparent positive correlation which is, however, totally explained by data corresponding to Germany and Ireland. In Germany, low productivity growth in the manufacturing sector has helped reduce aggregate wage and price inflation. The opposite is true in Ireland, where the productivity boom in tradables has generated wage and price inflation. In the remaining cases there is no clear association between inflation and productivity developments. In particular, in the rest of the high-inflation countries (Spain, Portugal, Ireland and the Netherlands), sectoral productivity growth differentials have been below the EMU average.

A second factor is price convergence. This may be caused by factors such as tax harmonisation, income convergence or trade liberalisation. The econometric evidence provided by Rogers (2002), with individual price data, and by Honohan and Lane (2003), with different aggregate price measures, shows however that price convergence is unlikely to explain much of the cross-country variation of inflation within the euro area, even after 1999.

A third explanation for persistent inflation differentials relies on the different cyclical positions of euro area countries which, possibly in combination with some nominal or real rigidities, could generate diverging price developments. Chart 2.2 depicts the variation of the output gap in each country over the period 1999-2003, together with average inflation. Here the existence of the expected positive correlation is clearer. Indeed, changes in the cyclical position may help explain the average inflation differential in Greece and Spain, though not in the Netherlands and Portugal.

A fourth explanation for persistent differentials could be the different exposure to oil prices and the exchange rate of the euro economies in an environment in which those variables have fluctuated widely. Indeed, the importance of extra euro-area trade in the Netherlands and Ireland, the depreciation of the euro in the first few years after the introduction of the euro and its subsequent appreciation may help partially explain the relatively high differential in these countries until 2003 and the fall observed thereafter. More generally, Hanohan and Lane (2003, 2004) provide evidence on a negative correlation between the effective exchange rate and national inflation figures in the euro area.

Therefore, the above evidence points to different factors being relevant for different countries. This phenomenon can be further illustrated by providing a simple inflation accounting exercise for the five high-inflation countries, as presented in Table 2.1.[1] In the table it is clear that domestic costs are more relevant than import costs for explaining the increase of the final demand deflator in Greece, Spain and Portugal, and, to a lesser extent, in Ireland, but not in the Netherlands. Moreover, while all five countries experienced high wage growth, its impact on inflation was significantly offset by high productivity growth in Greece and Ireland. Finally, profit markups made an important contribution to the GDP

[1] This is an update of some of the information contained in Table 3 of ECB (2003).

deflator differential in Greece, Spain and Ireland, but not in the Netherlands and Portugal. Thus, we can conclude that it is difficult to find a single explanation for persistent inflation divergence in EMU.

2.2 Some selected features of the Spanish economy affecting price developments

Having documented the diverse anatomy of inflation differentials in EMU, it would be worth concentrating on some aspect of the Spanish economy that might help identify the determinants and implications of the specific price developments in Spain. The following features probably merit being highlighted in that regard:

1. **Relatively high and stable growth based completely on domestic demand.**

   Chart 2.3 presents GDP in Spain and in the euro area since 1999 and the contributions of domestic demand and net exports. As can be seen, growth rates in Spain over the period were significantly higher than those of the euro zone. This was due to the strong expansion of domestic demand as the contribution of net exports has been persistently negative. In particular, domestic private consumption, especially services, and construction investment grew at rates well above that for overall GDP.[2] Those components benefited very directly from the marked reduction in nominal and real interest rates associated with the process of nominal convergence and EMU membership, and strong employment creation.

2. **Low productivity growth**

   Chart 2.4 depicts labour productivity and total factor productivity (TFP) in Spain and the euro area. Labour productivity growth has decreased in Spain by more than in the euro area since 1990. The labour market reforms implemented in the course of the nineties in connection with the increase in labour supply contributed to a marked decrease in the capital/labour ratio[3]. Moreover, as shown in the chart, TFP growth has also decreased substantially in the last ten years, remaining below the euro area average in the whole EMU period. Productivity performed poorly in both manufacturing and market services, although in 2003 the industrial sector saw a rise in productivity, linked largely to extensive job destruction.

[2] According to the available break-down of consumption in the Spanish National Accounts, average growth rate of consumption of services was 4,1 p.p., i.e. 1 p.p. higher than that of food or manufactured goods. Moreover from 1999 to 2003 the average growth rate of housing investments was around 6 p.p.

[3] The averate rate of growth of the Spanish participation rate during the period 99-03 was 1.4 p.p., almost 1 p.p. above the average growth rate in the nineties.

3. **Significant deviations from purchasing power parity and dual inflation**

   Table 2.2 presents an inflation accounting exercise for Spain somewhat more detailed than the that presented in Table 2.1. The inflation differential is now decomposed into the contribution of tradables and that of relative inflation between tradables and non-tradables (as in Estrada et al. 2004).[4] The exercise shows that inflation in tradables has made a sizeable contribution to the average inflation differential -measured in terms of the GDP deflator- since 1999. However, dual inflation between non-tradables and tradables account for about one-third of the total average differential. High growth in margins after 1999 -which are particularly noticeable in the non-tradable sector- explains a large part of both the total inflation differential and the dual inflation component[5]. Wage developments also make a significant contribution to overall price growth, although they do not seem to differ much across sectors. As expected from the above discussion, productivity growth does not exert a significant influence on the observed inflation differential.

4. **Persistent losses in competitiveness but moderate impact on trade**

   As can be seen in Chart 2.5, persistent inflation differentials have been associated with losses in competitiveness vis-à-vis the euro zone that range between 5% and 8% depending on the index used. Chart 2.6 depicts the export shares of Spanish products in the euro area since 1991. In this chart we also present data on the penetration of imports from the euro area in total domestic demand. Export shares and import penetration have been increasing steadily over the period as a consequence of Spain's economic development and progressively greater integration into the European economy, although both have decelerated in recent years. It is therefore difficult to identify any significant impact of the relatively high growth of prices and costs on the trade balance. Notwithstanding, it cannot be ruled out that the adverse course of competitiveness might contribute to explaining the more pronounced deceleration in export shares than in import penetration.

5. **Structural rigidities: more relevant in the labour market**

   We lack a sufficiently comprehensive comparative analysis of the functioning of goods and labour markets in different EMU countries. Still,the degree of competition and price flexibility in the product markets does not generally seem higher in Spain than in other euro-area countries (see Nicoletti et al., 1999). Moreover, some recently available microeconomic evidence on nominal price adjustments indicate that there is little idiosyncrasy in the pattern of price changes by Spanish retailers. Thus, Álvarez and Hernando (2004) find that the frequency of price changes (between six months and one year) and the proportion of downward corrections (around 40%) is remarkably close

[4] See also the Table 2.2. for a detailed description on how this decomposition has been constructed.

[5] Those are obtained as a residual, given observations on compensation per employee and productivity.

to the estimates available for other euro-area countries. In the labour market, there is not much evidence either pointing to particularly high nominal wage rigidity in Spain. However, there are some indications on specific wage rigidities in Spain associated, generally, with the prevailing wage-bargaining mechanisms. In particular, a system of backward price indexation (*cláusulas de salvaguardia*), which is currently present in around 80% of collective bargaining agreements, may contribute to generating inflation inertia. This type of indexation clause is not present in the standard labour contracts prevailing in most euro area countries[6]. This is therefore an idiosyncratic feature whose relevance will be explored in the simulation exercises performed in Section 3.

2.3 How does the Spanish economy react to inflationary shocks?

The above descriptive analysis already provides some hints on the likely causes of the persistent Spanish inflation differential. As a complement to that evidence and to start exploring the macroeconomic consequences of diverging price developments, it is useful to conduct some simulation analysis based on an estimated macroeconometric model. This will allow us to obtain some preliminary evidence on the effects of purely idiosyncratic shocks in a small open economy set up. In the next section we will perform similar exercises, but using a microfounded general equilibrium two-sector two-country model where we can also analyze the effects of common shocks (see below for details).

The model we employ here is the Quarterly Model of the Spanish Economy of the Banco de España described in Estrada et al. (2004). This is a relatively standard purely backward looking small open economy model with a single production sector, estimated through error correction-like specifications.

The first exercise we perform is an exogenous positive aggregate demand shock calibrated to produce a 1% impact effect on GDP. The shock is assumed to follow an AR(1) process with a persistence parameter of .9. In Chart 2.7 we present impulse-response functions for several variables of interest: GDP, HICP, domestic demand, consumption, contributions of net exports to GDP, terms of trade and exports.

The immediate effect of the shock is a direct increase in GDP that boosts consumption and investment. Deviation of prices from the baseline grows steadily up to thirteen quarters after the shock. Only then does it start to decrease slowly. That effect reduces real interest rates for at least two years. This, together with the lagged effects of the shock on expenditure, generates an expansion of domestic demand that exceeds the impact effect for two years before starting to converge to the baseline. The inflation differential only vanishes after five years. Net exports contribute to moderating GDP and, therefore, prices, but this is mainly due to import growth associated with larger final demand. The economy undergoes a

[6] According to the European Commission (2003), automatic wage indexation is only present in the majority of contracts in Belgium, Luxembourg and Spain. In the Netherlands, Greece, Finland and Italy, indexation clauses are occasionally included in some sectors. Finally, in Germany, France, Ireland and Portugal, there does not seem to be any explicit indexation mechanism.

moderate but extremely persistent loss in competitiveness that affects exports very gradually.

A second exercise we perform is a persistent decline in the nominal interest rate -an exogenous variable in this model- with a maximum effect on GDP of 1%. As can be seen in Chart 2.8, the impulse response functions are similar to those derived for the aggregate demand shock. The only noticeable difference is that the effects on output and prices are somewhat more persistent and peak later than with the aggregate demand shock. This is merely the consequence of lagged effects of interest rates on consumption and investment.

These exercises provide valuable insights as they seem to reproduce quite well some phenomena recently experienced by the Spanish economy. In particular, they suggest that the economy's recent expansion has been largely driven by the nature of the original expansionary shock -which is probably more persistent than that assumed in the exercises. But there have also been some relevant reinforcing effects associated with the reduction in real interest rates caused by higher inflation, as this has contributed to expanding further private expenditure. It also interesting to see that the terms of trade effect does not play a strong stabilising role as has been suggested sometimes in the literature (see e.g. Blanchard, 2001). Nevertheless, the deterioration in competitiveness has a very long-lasting impact on export performance.

In any case, the simulations performed provide only stylised facts of the adjustment process of the economy to different shocks. In particular, it does not allow us to identify the frictions in the functioning of the economy that could explain the path followed by different variables, particularly prices. As above noticed, in this small open-economy one-sector setting we cannot investigate the effects of common shocks to the euro area and those of specific sectoral shocks. We explore these issues in the next section.

3 A general equilibrium analysis

This section presents some simulation exercises in a newly developed macroeconomic model with a twofold purpose. First, we characterise the combination of shocks and frictions that may generate an inflation differential similar to that observed for Spain. Second, we illustrate the adjustment that, in the presence of the most likely shocks, would have taken place between domestic and foreign demand, both for nominal and real variables.Unlike with a standard macroeconometric model, a structural microfounded approach permits us to focus on the most recent period, i.e. that of Spain within the euro area.

Specifically, we consider a two-region currency area in which the monetary authority sets nominal interest rates to safeguard price stability in the area as a whole. In the steady state inflation is equal accross regions/countries, however over the business cycles there is domestic inflation variability and hence the real interest rate can be thought of as a country-specific variable. As we will consider a two-sector economy with tradable and non-tradable goods, we will be able to analyse the phenomenom of dual inflation (i.e. the rate of change in the relative price of non-tradable to tradable goods), and obtain more accurate measures of trade competitiviness.[7]

The model incorporates a number of nominal and real frictions that are now standard in the literature to match data persistence (see, for example, Christiano, EIchenbaum and Evans (CEE, 2004) for the US and Smets and Wouters (SW, 2003) for the euro area) although, for simplification, we do not incorporate capital accumulation. More specifically, the model displays price and wage rigidities. Among the latter we assume that there is a different degree of wage indexation in the two countries, as was suggested in the previous section.

On the real side, we allow for non-perfect substitutability between tradable and non-tradable consumption goods, as well as between foreign and domestically produced tradable goods. We also introduce external habits in consumption to generate a persistent hump-shaped response of output. Finally, inspired by the evidence presented in section 2, a fraction of consumers (spenders or rule of thumbers) are assumed to have no access to financial markets to smooth consumption over time (as recently emphasised by Gali et al. (2003)). As predicted by most large-scale macromodels (including the *Quarterly Model of the Banco de España)*, and by the recent VAR literature, there seems to be a crowding-in effect of government spending shocks (or any other autonomous expenditure shock) on private consumption. This effect cannot be reproduced in pure neoclassical set-ups, where consumption is crowded out by exogenous demand shocks. A simple way to avoid this counterfactual crowding-out effect is to assume that not all consumers are able to smooth consumption over time.

3.1 Model description and calibration

The Appendix presents a relatively detailed description of the model employed. In this section we simply outline the structure of the economy, agents' objectives and some relevant equilibrium conditions.

The two countries (or regions), domestic (H) and foreign (F), are symmetric and share the same currency. Each country is specialised in the production of a continuum of varieties of tradable (Y_T) and non-tradable goods (Y_N). Labour (L) is the only production factor and each specific factor can be moved across sectors but not across regions.

Households provide labour and consume all varieties of domestic goods (C_T and C_N) as well as foreign tradable goods (C_F). The baskets for total consumption (C) and tradable goods (C_T) are assumed to follow a CES form, where the parameters γ and $\phi \in [0,1]$ represent the share of traded goods in total consumption and the share of home-produced goods in total traded goods, respectively. Households are wage-setters in the labour market, and wages are set using a Calvo-type contract. A given fraction of these households $(1-\lambda)$ have access to capital markets and in particular to a riskless bond that pays a gross nominal interest rate R_t at any state of the world. The other fraction of households (λ) do not have access to the capital markets and do not save, i.e. they consume their disposable income

[7] Duarte and Wolman (2002) and Altisimo et al. (2004) also consider a two-sector economy to analyse inflation differentials in the euro area. Yet none of these authors look quantitatively at the relative importance of the dual inflation phenomena.

resulting from working a certain amount of hours. At the prevailing wage firms allocate their labour demand uniformly across the two type of households.

Firms are monopolistically competitive producing differentiated intermediate goods. Each production function presents decreasing returns to labour. These intermediate goods are used as an input by a (perfectly competitive) firm producing a single final good in each sector. Intermediate firms set prices in a staggered fashion also following a Calvo contract.

Monetary policy sets the nominal interest rate each period following a simple Taylor rule that gives a lower weight to the Spanish economy relative to the rest of the area. This is the simplest way to model the different relevance of the two economies in the determination of the area-wide monetary stance. We now describe some equilibrium conditions that aim to capture the key demand and supply ingredients of the model, so helping to understand the determinants of inflation differentials and the macroeconomic adjustment in the domestic economy.

Demand equilibrium conditions[8] A log linear approximation around the steady state of the consumption Euler equation of the non-restricted or optimisers consumers (c_t^o) yields

$$c_t^o = \omega c_{t-1}^o + (1-\omega) E_t c_{t+1}^o - \frac{1}{\sigma}(r_t - E_t \pi_{t+1})$$

where $\omega = \frac{\eta}{1+\eta}$, and $0 \leq \eta < 1$ is the external habits parameter. In particular, this is a standard equibrium relationship where consumption is a function of the real interest rate, but given the habit formation assumption, it also depends on a weighted average of past and future consumption. Hence, the previous expression can be solved for consumption as a function of past consumption and the long run real interest rates, i.e.

$$c_t^o = \eta\ c_{t-1}^o - \frac{1+\eta}{\sigma} \sum_{k=0}^{\infty}\ E_t\{r_{t+k} - E_t \pi_{t+k+1}\}$$

The external habits parameter, η, can be thought of as an indicator of the degree of consumption (demand) persistence in response to long-run real interest rates. In addition, the existence of complete markets implies that the marginal utilities of consumption between non-restricted consumers in the domestic and the foreign economy (c_t^*) are equal,[9]

$$\sigma(c_t^o - c_t^*) - \eta(c_{t-1}^o - c_{t-1}^*) = \{p_t^* - p_t\}$$

where, under the assumption of log utility and no habits, the previous expression links relative prices to relative consumptions for non-restricted households across the area.

[8] Here we focus on some equilibrium conditions where the variables are expressed in log deviations from their steady state.

[9] We are assuming that preferences are equal in both countries of the area.

In the domestic economy, the allocation of the total consumption will also depend upon the dynamics of disposable income, and hence on real wages and labour. This is so because the rule of thumb consumers (C^r) will equate consumption to their (net) labour income (see Galí, et al. (2003).) Formally,

$$c_t^r = (w_t - p_t) - \chi l_t$$

Aggregate consumption becomes a convex combination of both types of consumption, i.e.

$$c_t = \lambda c_t^r + (1-\lambda) c_t^{\circ}$$

The allocation of consumption accross home produced, non-traded, and imported depends upon the evolution of relative prices according to the elasticities of substitution among consumption goods as well as the shares (i.e. γ and ϕ) -see Appendix for details.-

We now turn to the dynamics of net exports. A linear approximation to net exports yields

$$nx_t = -(1-\phi)\gamma(\zeta - 1)\ tt_t + (1-\phi)\gamma(c_{T,t}^* - c_{T,t}) \tag{1}$$

where ζ represents the elasticity of substitution between tradable domestic and imported goods. Net exports will depend upon the behavior of the terms of trade, (i.e. $tt_t \equiv p_{H,t} - p_{F,t}$) as well as the relative demands of tradable goods. Notice that an increase in the terms of trade, i.e. an increase in the relative prices of domestic goods to imported goods is aimed at capturing loss in competitiveness, and hence it will lead to a direct reduction in net exports.

Supply equilibrium conditions The dynamics of prices and wages in each country are determined by the corresponding optimal decisions of firms and households. The sectoral price equations are a function of expected future price markups, and lag inflation (given indexation of price contracts); and the sectoral wage equations are a function of expected future wage markups and lag inflation (given indexation of wage contracts.) Formally, if we concentrate on the domestic economy we have

$$\{\pi_{J,t} - \delta_p \pi_{t-1}\} = \beta E_t\{\pi_{J,t+1} - \delta_p \pi_t\} - \lambda_{p,J}\ \mu_{J,t}^p$$

$$\{\pi_{J,t}^w - \delta_w \pi_{t-1}\} = \beta E_t\{\pi_{J,t+1}^w - \delta_w \pi_t\} - \lambda_{w,J}\ \mu_{J,t}^w$$

for $J = T, N$, respectively, and where π_J, π_J^wrepresent the rate of growth of sectoral prices and nominal wages, respectively. Finally, as noticed above, the driving forces of both prices and wages are the sectoral price markups ($\mu_{J,t}^p$) defined as the difference between sectoral labour productivity and real wages, and the wage markup ($\mu_{J,t}^w$) defined as the difference between the sectoral real wage and the household marginal rate of substitution.[10] The

[10] See, for instance, Erceg, et al. (2000) and Galí, et al. (2003).

influence of these variables on prices and wages is determined by the slope coefficients ($\lambda_{p,J}$ and $\lambda_{w,J}$, respectively), which depend on the average duration of the contracts, the elasticity of the goods and labour demand curves, the extent to which there are decreasing returns to labour over the business cycle, and the slope of labour supply. Additionally, the indexation parameters ($\delta' s$) indicate the proportion of firms/workers that adjust their prices to past inflation when they can not be adjusted optimally.

Accounting for inflation differentials Given the structure of the model, it is possible to obtain an expression for the inflation differentials between domestic economy and foreign, i.e. $\pi_t - \pi_t^*$. Formally, it can be shown that[11]

$$\pi_t - \pi_t^* = (1-\gamma)(\pi_{N,t} - \pi_{H,t}) - (1-\gamma^*)(\pi_{N,t}^* - \pi_{F,t}) + \varphi \Delta tt_t$$

where φ represents the effects of terms of trade fluctuations on inflation differentials. Formally $\varphi = (\phi - \phi^*) + (1-\gamma^*)\phi^* + (1-\gamma)(1-\phi)$. There are, therefore, three main sources of inflation differentials, the two relative dual inflation terms, i.e. the differences between non-tradable and domestically produced tradable goods in both economies, and changes in the terms of trade. Interestingly, assuming no home bias (i.e. $\phi = \phi^*$) and the same consumption structure across countries (i.e., $\gamma^* = \gamma$) would imply that inflation differentials are merely a function of changes in relative prices of non-tradable goods.

Calibration Table 3.1 describes the calibration that we use as a benchmark. Each period is assumed to be one quarter, so a discount rate β of 0.99 implies a steady state annual real interest rate of 4%. The utility function is separable and assumed to be logarithmic in both arguments, C and L. Thus, the risk aversion parameter (σ) is 1 as is also the elasticity of wages with respect to hours (χ). The external habit stock (h) is estimated at 0.7, somewhat higher than that estimated by SW (2003). The proportion of constrained consumers (λ) is 0.5.

The elasticity of substitution between tradable and non-tradable (ρ) is 0.44, the value estimated by Stockman and Tesar (1995), and the elasticity of substitution between domestic and foreign traded goods (ξ) is 1.5, as in Backus et al. (1995). The elasticity of substitution between labour across sectors (ν) is set equal to -1, consistent with the perfect mobility case. The share of tradable goods in the consumption basket in the domestic economy (γ) is 0.5 and the proportion of domestic goods in the tradable basket (ϕ) is 0.75. However, the share of domestic goods in the foreign consumption basket of tradable (ϕ^*) is assumed to be only 0.2, in order to represent a smaller penetration of imports from the domestic economy.

[11] In the model we do not allow for price discrimination between domestically produced goods and exports, since the law of one price applies to both imported (F) and domestically produced tradable goods (H). Therefore, p_H will capture the price of exported goods as well as the price of domestically produced goods consumed inside the country. Symmetrically, p_F will reflect both the price of imported goods for the domestic economy as well as the price of those domestically produced and consumed in the foreign economy.

In the production function the labour share (α_J) is 0.7, consistent with the average euro area data. The elasticity of substitution across goods, ϵ_p, is set such that it implies a 10% steady state markup; and the elasticity of substitution across labour goods, ϵ_w, implies a 5% steady state wage markup (as in CEE.) We also abstract from country or sectoral asymmetries in prices and labour mobility, although we assume higher stickiness in the labour market than in the goods market. The fraction of firms that keep their prices unchanged (θ_p) is 0.65, which corresponds to an average price duration of slightly less than three quarters, and the fraction of households that keep their wages unchanged (θ_w) is 0.75 implying an average wage contract duration of one year. There is full indexation in the goods markets (δ^p_J=1) but, as suggested in section 2, we assume that there is asymmetry across countries in the degree of wage indexation (δ^w_{J*}=0.4, δ^w_J=0.8).

We set the policy parameter that measures the response of the interest rates to aggregate inflation, ϕ_π, to 1.5, a value commonly used in the Taylor rules. The weight of domestic (Spanish) inflation on the rule is 0.1.

Therefore, in our benchmark specification we make rather prudent assumptions regarding the degree of heterogeneity across sectors and countries. Thus, we assume the same price and wage behaviour across sectors. Moreover, the two-country economies are modelled in a similar manner except in what is directly influenced by their size -which affects both the consumption baskets and the arguments of the monetary policy rule- and the different wage setting behaviour. This conservative approach seems justified on the basis of the available evidence for the Spanish economy. We will, however, conduct some sensitivity analysis later on.

3.2 Sources of fluctuations and inflation differentials

We have conducted several simulation exercises corresponding to area-wide, country-specific, or country and sector-specific shocks. Thus we contemplate: i) a common monetary policy shock; ii) an aggregate productivity shock in the domestic economy; iii) a productivity shock to the sector of tradables in the domestic economy, iv) a preference (aggregate consumption) shock in the domestic economy; and v) a shock to the demand for non-tradables in the domestic economy. All shocks follow an AR(1) process with persistence parameter of 0.9 and a variance calibrated to produce a change in total output of 1% in each case.

We focus for the time-being on inflation differentials and present in Table 3.2 some statistics expressing the maximum impact of each shock on the inflation differential between the two economies and the accumulated effect over 12 quarters. We also represent the accumulated impact on the inflation differential between domestically produced tradable goods and imports ($\pi_H - \pi_F$) and domestic dual inflation ($\pi_N - \pi_H$).

Starting with the common monetary policy shock, the simulation performed shows that there is essentially no effect on inflation differentials. The asymmetry assumed in the wage setting mechanism and the degree of openness is therefore not sufficient to generate aggregate price dispersion between the two economies. This shock does however create significantly more inflation in the tradable sector than in the non-tradable sector (a negative dual inflation effect). This is due to the spill-over effects associated with the foreign demand increase in domestically-produced tradable goods in both economies.

The (positive) productivity shocks in the domestic economy are not able either to generate positive inflation differentials in the domestic economy. Not surprisingly, an aggregate positive supply shock does not only increase output but also reduces the price level (which translates into negative persistent inflation as a consequence of price and wage rigidities) in both sectors. Probably more interesting is the case of a productivity shock in the domestic tradable sector. Consistent with the Balassa-Samuelson hypothesis, this shock generates substantial dual inflation as nominal wages increase in both sectors -there is perfect labour mobility across sectors and wage indexation to the aggregate inflation rate- but productivity only increases in one of them. However, domestic traded goods become much less expensive than foreign goods due to the sectoral technological improvements. Under our calibration ($\phi > \phi^*$) this terms of trade effect is slightly more important than the dual inflation effect, thereby generating a small negative inflation differential. This result has been previously obtained by Benigno and Thoenissen (2003).

As for country-specific demand shocks, both an aggregate consumption (preference) shock and a shock to non-tradables demand generate positive inflation differentials as expected. The differential is larger and more persistent in the case of the preference shock. The reason is that in this forward looking model only the corresponding part of the exogenous demand shock in non-tradables will crowd out consumption of non-rationed agents, thereby reducing aggregate demand and requiring a smaller price adjustment to return to equilibrium.[12]

While the non-tradable demand shock generates a significant dual inflation effect, this is not present in the case of an aggregate consumption shock. Therefore, in this model, in which price and wage setting are similar across sectors, dual inflation can only be generated by a demand shock if this is biased towards non-tradable goods.

3.3 Sensitivity analysis

In order to check the robustness of the results to some changes in the parameters of the model, we perform simulations with alternative calibrations. In particular, we are interested in analysing the sensitivity of the results to a higher degree of country and sector heterogeneity. We focus on the price indexation parameters to past inflation (parameters δ^p's) since, in principle, the assumption made on the similarity of the price-setting rules across sectors and countries may be considered particularly strong. Moreover, we concentrate on the three demand shocks, as the productivity shocks seem unable to generate both output expansion and positive inflation differential in the domestic economy as has been observed in Spain. In Table 3.3, we present simulation results corresponding to two different modifications of the

[12] This effect is obviously not present in the case of a direct consumption shock.

benchmark model: i) price indexation is dropped in the foreign country; ii) price indexation is dropped in both the foreign economy and the domestic tradable sector.

As can be seen in Table 3.3, considering no price indexation in the foreign economy and full price indexation in the domestic one does not qualitatively change much the effects of both demand shocks in the domestic economy: namely, inflation differentials are positive for both country specific shocks and the dual inflation effect is only present if the demand shock is specific to non-traded goods. However, this asymmetry introduces a relevant source of cross-country heterogeneity into the transmission of monetary policy impulses. Unlike with the benchmark calibration, a common monetary policy shock generates in this case a positive inflation differential in the domestic (now more rigid) economy. Nevertheless, this common shock is still having a significantly larger inflationary effect on tradables than on non-tradable goods.

It could be considered, that the monetary policy shock and the domestic aggregate consumption shock could be generate a positive differential between inflation in non-tradables and tradables if we allowed for more sector heterogeneity. Indeed, as shown in the second line of Table 3.3, if price indexation is only limited to the non-tradable sector in the domestic economy, the preference shock now generates a dual inflation effect, albeit of a relatively small size. Similarly, the monetary policy shock now has a more symmetric impact on both domestic sectors although, in this case, inflation is still larger in tradables. Given the extreme assumption made on the asymmetry of the degree of price indexation across sectors, these simulations suggest that the phenomenon of dual inflation can hardly be explained in this setting without sector-specific shocks.

For completeness, we have conducted a third exercise consisting of removing completely price indexation in both economies while maintaining wage indexation, as in the benchmark calibration. The results, which are also presented in Table 3.3 (third line), are qualitatively similar to those corresponding to the benchmark model. The only shock which is able to generate both a positive inflation differential and dual inflation is an increase in the domestic demand for non-tradables, although its effect is, as expected, slightly smaller than in the model that included price indexation. Therefore, the exercise indicates that a relatively high degree of wage indexation in the domestic economy has much power in explaining the persistence of inflation differentials in the domestic economy.

3.4 The adjustment process

The above analysis seems to support the idea that the expansion of the demand for non-tradable goods and wage indexation in the labour market are likely to feature among the key determinants of inflation developments in Spain over the last few years. Still, as seen in Section 2, although clearly larger for non-tradable products, consumption expansion in the Spanish economy has been relatively widespread. We have seen, however, that while a purely aggregate consumption shock can generate persistent inflation differentials in our model, it does not contribute to dual inflation –a well-established characteristic of the Spanish inflationary process- unless additional heterogeneity is imposed across sectors. Thus, as a way to increase our ability to reproduce some relevant aspects of Spanish economic developments, we have combined both an aggregate consumption shock and a shock to the demand for non-tradables and introduce a relatively higher degree of indexation in the price-setting rule in the non-tradable sector than in tradables. Although it is hard to find strong direct evidence to support that latter assumption, incorporating a lower degree of price flexibility in services than in tradable sectors is relatively common in the literature (see e.g. Costa-Dias and Neves, 2004, Le Bihan and Sevestre 2004 and Altissimo et al., 2004). Moreover, evidence for the Spanish economy (again in line with that for the euro area) shows that the proportion of downward price revisions in services is lower than that in food or industrial goods (see Alvarez and Hernando 2004).

It is therefore worth looking at the adjustment paths of a model with the above features subject to a composite demand shock. That exercise can only be, however, a very stylised representation of the experience of the Spanish economy. In particular, the economy has been subject to an idiosyncratic real interest rate shock that cannot be incorporated into our setting since nominal interest rates are common for the euro area and domestic inflation is a purely endogenous variable. In any case, an exercise assuming a (composite) exogenous demand shock may provide a good proxy for the effects of a more realistic lower interest rate scenario, as actually proved to be the case in the simulations conducted in Section 2 with an estimated macroeconometric model.

We have therefore performed a new simulation exercise of a composite shock consisting of two independent shocks : a shock to aggregate consumption (preferences) and an exogenous demand shock to non-tradable goods. As before, both shocks have a persistence parameter of .9 and are calibrated so as to yield an impact effect on GDP of .5% each. In addition, the indexation parameter (δ_p) is set to .5 in the tradable sector but remains at 1 in the non-tradable sector. The rest of the parameters are as in the benchmark calibration.

In Chart 3.1 we present the impulse-response functions for some key variables. By construction, the shock generates immediately a 1% expansion of output. Aggregate consumption grows close to that rate due to the presence of rule-of-thumb consumers that generate a crowding-in effect of the non-tradable demand shock. This adds to the direct impact on optimising-consumers' expenditure of the preference shock. As expected, a country-specific demand shock biased towards non-tradable goods in combination with asymmetric wage and price indexation across sectors generates an inflation differential which is larger and more persistent than in the case of a pure non-tradable demand shock. Moreover, the exercise yields a significant dual inflation phenomenon. The foreign economy experiences a small contraction as a consequence of the effect of higher domestic inflation on interest rates through the monetary policy rule. This in turn helps contract exports of the domestic economy and moderate the impact of the shock on the price of domestic tradable goods. Interestingly, as occurred with the simulations performed with the estimated macroeconometric model for the Spanish economy, net exports only decline very moderately and, therefore, does not help stabilise the economy much after the shock. Finally, the impact of the shock on the terms of trade is relatively mild but very persistent, so it implies sustained losses in competitiveness

4 Conclusions

In this paper we have presented some descriptive evidence and simulation exercises with both an estimated backward looking model and a calibrated general equilibrium forward looking model that allow some light to be shed on the determinants and macroeconomic implications of persistent inflation differentials in Spain. We have shown that an aggregate demand expansion beyond what could be purely justified by disposable income growth and biased towards consumption of non-tradable goods -such as services and housing- is likely to be the main driving force behind diverging price developments in this country. The relatively high persistence of those demand developments on domestic inflation seems largely due to the inertial components of the price and wage-setting rules of the economy among which some forms of real wage rigidities, such as those caused by wage indexation clauses, seem to play a predominant role. In addition, the size and persistence of inflation differentials in combination with the dual inflation phenomenon seem to suggest that prices in non-tradable sectors could be somewhat more rigid than in tradables. This feature, more than cross-country differences in price behaviour, may significantly help amplify the relative inflation effects of the idiosyncratic demand expansion.

Moreover, we have provided new evidence that further supports the idea that Balassa-Samuelson effects have not played any significant role in the recent past. Not only does the Spanish economy not seem to have been subject to any aggregate or sector-specific positive technology shock, but it would have been unlikely for this to have translated into a positive inflation differential.

Having identified the likely determinants of Spanish inflation differentials we were in a position to investigate their implications for the real economy. We have found that, in general, the deterioration of the terms of trade that inflation differentials cause does not have a quantitatively relevant stabilising effect as its impact on output is relatively small in the short term. It does however depress exports in a moderate but persistent manner as the economy's loss of competitiveness is only absorbed after a long period. This effect is obtained in model simulations that do not incorporate any hysteresis in the response of exports to a real.appreciation.

Therefore, to the extent that the persistent inflation differentials of the Spanish economy are not linked to a structural catching-up process, the self-correction mechanisms are relatively weak, and may generate long-lasting losses in competitiveness, diverging price developments are of policy relevance for domestic authorities.

In the Spanish case, in the absence of an autonomous monetary policy, fiscal policy and, in particular, government consumption seems, in principle, a powerful instrument to contain private demand pressure especially if, as is the case in Spain, this is largely concentrated on non-tradable goods. Moreover, even if the Spanish economy does not apparently have larger nominal or real rigidities in product markets than other euro-area countries, the macroeconomic impact may be more damaging since, as has been shown, they tend to amplify the adverse effects of country-specific expansionary shocks on competitiveness. But, more importantly, given the key role played by real wage rigidities in generating persistent inflation differentials, the economy will clearly benefit from more flexible labour contracts and, particularly, from a less generalised inclusion of wage indexation clauses.

References

Alberola, E. and T. Tyrväinen (1998): "Is there scope for inflation differentials in the EMU?," Banco de España Working Paper 9823.

Alberola, E. (2000): "Interpreting inflation differentials in the euro area," Bank of Spain Economic Bulletin 61-70, April

Altissimo, F.; P. Benigno, and D. Rodriguez-Palenzuela (2004): "Inflation differentials in a currency area: some facts and explanations," mimeo ECB.

Andrés, J.; E. Ortega and J. Vallés (2003): "Market structure and inflation differentials in the European Monetary Union," Banco de España Working Paper 0301.

Angeloni, I. and M. Ehrmann (2004): "Euro Area Inflation Differentials," ECB Working Paper 388.

Backus, D. K., Kehoe, Patrick and Finn Kydland (1995), "International Business Cycles: Theory and Evidence," in *Thomas F. Cooley (ed.) Frontiers of Business Cycle Research*, Princeton University Press, 331-356.

Balassa, B. (1964): "The Purchasing Power Parity Doctrine: A Reappraisal", *Journal of Political Economy,* 72.

Benigno, P. (2003), "Optimal Monetary Policy in a Currency Area," *Journal of International Economics*, forthcoming.

Benigno, P, and D. López-Salido (2003): "Inflation Persistence and Optimal Monetary Policy in the Euro Area, " ECB Working Paper 178.

Benigno, G. and L. Thoenissen (2003): "Real Exchange Rate Rates and Supply-Side Performance," *The Economic Journal*, vol. 113, (486), 103-124.

Blanchard, O.J. (2001):"Country Adjustments within Euroland. Lessons after Two Years", mimeo at http://econ-www.mit.edu/faculty/blanchar

Christiano, L.; M. Eichenbaum and C. Evans (2003): "Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy," *Journal of Political Economy*, forthcoming.

Costa-Diaz, M. and P. Neves (2003), "Stylised Features of Price Setting Behaviour," unpublished manuscript, Banco de Portugal.

Duarte, M. and A. Wolman (2002): "Regional Inflation in a Currency Union: Fiscal Policy vs. Fundamentals," ECB Working Paper 180.

ECB (2003): "Inflation Differentials in the Euro Area: Potential Causes and Policy Implications."

Erceg, C.J., Henderson, D.W., Levin, A.T., (2000). Optimal monetary policy with staggered wage and price contracts," *Journal of Monetary Economics* 46, 281–313.

Estrada, A, J. Galí and D. López-Salido (2004): "Accounting for Euro-zone Inflation Differentials.", mimeo, Banco de España.

Estrada, A, J. Fernández, E. Moral and A. V. Regil (2004): "A quarterly macroeconometric model of the Spanish economy," Banco de España Working Paper 0413.

Galí, J.; M. Gertler and J.D. López-Salido (2002): "Markups, gaps, and the welfare costs of business fluctuations," Banco de España Working Paper 0204.

Galí, J. J.D. López-Salido and J. Vallés (2003), "Understanding the effects of government spending on consumption," Banco de España Working Paper 0321.

Le Bihan, H. and P. Sevestre (2004), "Analyzing French CPI Micro-Data: Some Preliminary Notations and Results," unpublished manuscript, Banque de France and IPN.

López-Salido, D., F. Restoy and J. Vallés (2000), "Inflation differentials and dual inflation in the euro area," mimeo

Honohan, P. and P. Lane (2003): "Divergent Inflation rates in EMU" *Economic Policy,* October, 357-394.

Honohan, P. and P. Lane (2004): "Exchange Rates and Inflation under EMU: An Update" July 2004, http://www.tcd.ie/iiis/plane/papers.html.

Nicoletti, G., S. Scarpetta y O. Boylan (1999): "Summary indicators of product market regulation with an extension to employment protection legislation," OECD WP. 226.

Obstfeld, M. and K. Rogoff (2000): "New Directions for Stochastic Open Economy Models," *Journal of International Economics*, 50, 117-153.

Ortega, E. (2003): "Persistent inflation differentials in Europe, " Banco de España Working Paper 0305.

Rogers (2002): "Monetary union, price level concergence, and inflation: How close is Europe to the United States?", Working Paper 740, International Finance Discussion Paper, Board of Governors of the Federal Reserve System.

Samuelson, P. A. (1964): "Theoretical Notes on Trade Problems", *Review of Economics and Statistics* 46.

Smets, F. and R. Wouters (2004): "An Estimated Stochastic Dynamic General Equilibrium Model of the Euro Area," *Journal of the European Economic Association*, 1(5), 1123-1175.

Stockman, A. and L. Tesar (1994): "Tastes in a Two Country Model of the Business Cycle: Expalining International Comovement," *American Economic Review*, 85 (1), 168-185.

Appendix. The model

In this appendix, based upon our companion paper (López-Salido, Restoy and Vallés (2004)), we describe the two-country-two sector model. The domestic economy is populated by two types of households, optimisers (or savers) and those that have no access to financial markets (restricted or spenders). Households have monopoly power over the different varieties of labour they can supply, so that they act as wage setters. There are two sectors in the economy: the tradable goods and the non-tradable goods sectors. In each sector there is a continuum of monopolisitically competitive firms that set prices in a staggered fashion. Finally, there is a central bank that sets the nominal interest rates for the whole area.

Households

1. Optimisers

The preferences of a generic intermporal optimiser household h are given by

$$E_0 \sum_{t=0}^{\infty} \beta^t e_t [\frac{1}{1-\sigma} \left(\frac{C_t^o(h)}{H_t} \right)^{1-\sigma} + \frac{\kappa}{1+\chi} L_t^o(h)^{1+\chi}] \tag{2}$$

where C_t^o and L_t^o are a composite of household consumption goods and labour effort, with $\chi \geq 0$, $\sigma \geq 0$, and $0 < \beta < 1$. The variable e_t is a preference shock that will not affect the marginal rate of substitution between consumption and hours. The utility functions depends positively on consumption relative to an external habit variable, H_t, which is assumed to be a function of aggregate past consumption, i.e.

$$H_t = C_{t-1}^{\eta} \tag{3}$$

with $0 \leq \eta < 1$. Notice that under $\eta = 0$ preferences correspond to the standard CRRA case.

Let C_t^o be a CES index that defines household preferences over tradable consumption, $C_{T,t}^o$, and non-tradable consumption, $C_{N,t}^o$:

$$C_t^o = \left[(\gamma)^{\frac{1}{\rho}} \left(C_{T,t}^o \right)^{\frac{\rho-1}{\rho}} + (1-\gamma)^{\frac{1}{\rho}} \left(C_{N,t}^o \right)^{\frac{\rho-1}{\rho}} \right]^{\frac{\rho}{\rho-1}} \tag{4}$$

where $C_{T,t}^o$ is a composite index over tradables produced at home-domestically consumed, $C_{H,t}$, and tradables made by foreigners, $C_{F,t}^o$:

$$C_{T,t}^o = \left[(\phi)^{\frac{1}{\zeta}} \left(C_{H,t}^o \right)^{\frac{\zeta-1}{\zeta}} + (1-\phi)^{\frac{1}{\zeta}} \left(C_{F,t}^o \right)^{\frac{\zeta-1}{\zeta}} \right]^{\frac{\zeta}{\zeta-1}} \tag{5}$$

The parameters γ and $\phi \in [0,1]$ represent the share of traded goods in total consumption and the share of home-produced goods in total traded goods, respectively. The parameters $\rho > 1$ and $\zeta > 1$ represent the elasticity of substitution between goods.

Each country produces a continuum of varieties of the tradable goods, indexed by $i \in [0,T]$, and a continuum of non-traded goods indexed by $j \in [T,1]$. In this economy,

$C_{H,t}$ and $C_{N,t}$, and $C_{F,t}$ are aggregates of the continuum of varieties. These varieties are imperfect substitutes with elasticity of substitution $\varepsilon_J > 1$, for $J = H, N, F$. Formally, we have it that $C_{H,t} \equiv \left(\int_0^T C_{H,t}(i)^{\frac{\varepsilon_H - 1}{\varepsilon_H}} di\right)^{\frac{\varepsilon_H}{\varepsilon_H - 1}}$, $C_{N,t} \equiv \left(\int_T^1 C_{N,t}(j)^{\frac{\varepsilon_N - 1}{\varepsilon_N}} dj\right)^{\frac{\varepsilon_N}{\varepsilon_N - 1}}$, and $C_{F,t} \equiv \left(\int_0^{T^*} C_{F,t}(i)^{\frac{\varepsilon_F - 1}{\varepsilon_F}} di\right)^{\frac{\varepsilon_F}{\varepsilon_F - 1}}$ for tradable home-produced, non-tradables, and imported consumption goods, respectively.[13]

From the previous assumptions it follows that the price indexes defined as the minimun expenditure necessary by one unit of the corresponding composite good leads to

$$P_t = \left[(\gamma)(P_{T,t})^{1-\rho} + (1-\gamma)(P_{N,t})^{1-\rho}\right]^{\frac{1}{1-\rho}} \tag{6}$$

and

$$P_{T,t} = \left[(\phi)(P_{H,t})^{1-\zeta} + (1-\phi)(P_{F,t})^{1-\zeta}\right]^{\frac{1}{1-\zeta}}, \tag{7}$$

where P_t is the consumption-based price index; $P_{T,t}$ and $P_{N,t}$ are the aggregate price indexes of tradable and non-tradable composite consumption goods. Finally, $P_{H,t}$ and $P_{F,t}$ are the price indexes of tradable domestically consumed goods and imported tradable goods. Formally, these price indexes are $P_{H,t} = \left(\int_0^T P_{H,t}(i)^{1-\varepsilon_H} di\right)^{\frac{1}{1-\varepsilon_H}}$, $P_{N,t} = \left(\int_T^1 P_{N,t}(j)^{1-\varepsilon_N} dj\right)^{\frac{1}{1-\varepsilon_N}}$, and $P_{F,t} = \left(\int_0^{T^*} P_{F,t}(i)^{1-\varepsilon_F} di\right)^{\frac{1}{1-\varepsilon_F}}$ for home-produced, non-tradable, and imported consumption goods, respectively. The optimal allocation of any given expenditure within each category of goods yields the following demand functions: $C_{H,t}(i) = \left(\frac{P_{H,t}(i)}{P_{H,t}}\right)^{-\varepsilon_H} C_{H,t}$, $C_{N,t}(i) = \left(\frac{P_{N,t}(i)}{P_{N,t}}\right)^{-\varepsilon_N} C_{N,t}$, and $C_{F,t}(i) = \left(\frac{P_{F,t}(i)}{P_{F,t}}\right)^{-\varepsilon_F} C_{F,t}$.

Finally, the optimal allocation of expenditures between non-traded and traded goods as well as between traded home-produced and imported goods imply:

$$C_{T,t} = \gamma \left(\frac{P_{T,t}}{P_t}\right)^{-\rho} C_t \tag{8}$$

$$C_{N,t} = (1-\gamma) \left(\frac{P_{N,t}}{P_t}\right)^{-\rho} C_t \tag{9}$$

$$C_{H,t} = \phi \left(\frac{P_{H,t}}{P_{T,t}}\right)^{-\zeta} C_{T,t} \tag{10}$$

and

$$C_{F,t} = (1-\phi) \left(\frac{P_{F,t}}{P_{T,t}}\right)^{-\zeta} C_{T,t}. \tag{11}$$

[13] Given the symmetry between optimiser $'o'$ and rule-of-thumb consumers $'r'$ in the intratemporal optimal allocation of consumption and hours worked we have eliminated the superscript $'o'$ in this section.

Each firm uses a specific labour factor and each household can supply all varieties of labour in the country to produce traded and non-traded goods. To capture frictions in labour mobility, we also assume that labour effort might not be perfectly substitutable across sectors. In particular, $L_t(h)$ is a CES composite of $L_{N,t}(h)$ and $L_{T,t}(h)$, as follows:

$$L_t(h) = \left[(\psi)^{1+v} \ \ (L_{T,t}(h))^{-v} + (1-\psi)^{1+v} \ \ (L_{N,t}(h))^{-v}\right]^{-\frac{1}{v}} \ , \tag{12}$$

with $\psi \in [0,1]$ is the fraction of labour effort that will be employed in the tradable sector, and $(1+v)^{-1} > 0$ captures the degree of substitution between the two varieties of labour. When $v = -1$ the elasticity of substitution between labour efforts is infinite, hence it is very easy to switch from one labour into another, while the value $v = 0$ corresponds to a Cobb-Douglas specification. These intra-temporal labour adjustment costs are meant to capture the idea that the reallocation of labour from one sector to the other is costly for the household. In particular, as $v \leq -1$ gets smaller, it becomes increasingly difficult to reallocate labour from one sector to the other.[14]

In this economy, $L_{T,t}(h)$ and $L_{N,t}(h)$ are a composite index of a continuum of imperfectly substituted varieties of labour with elasticity of substitution $\varepsilon_w > 1$, $L_{T,t}(j) \equiv \left(\int_0^1 l_{T,t}(i)^{\frac{\varepsilon_w - 1}{\varepsilon_w}} \ di\right)^{\frac{\varepsilon_w}{\varepsilon_w - 1}}$, and $L_{N,t}(j) \equiv \left(\int_0^1 l_{N,t}(i)^{\frac{\varepsilon_w - 1}{\varepsilon_w}} \ di\right)^{\frac{\varepsilon_w}{\varepsilon_w - 1}}$. The optimal allocation of labour within each category yields the following labour demand functions for each variety of labour supplied to a generic firm in both sectors:

$$l_{T,t}(i) = \psi \left(\frac{W_{T,t}(i)}{W_{T,t}}\right)^{-\varepsilon_w} \left(\frac{W_{T,t}(h)}{W_t(h)}\right)^{-\frac{1}{1+v}} L_t(h)$$

$$l_{N,t}(i) = (1-\psi) \left(\frac{W_{N,t}(i)}{W_{N,t}}\right)^{-\varepsilon_w} \left(\frac{W_{N,t}(h)}{W_t(h)}\right)^{-\frac{1}{1+v}} L_t(h) \ ,$$

where the wage indexes take the form:

$$W_{T,t}(h) = \left(\int_0^1 W_{T,t}(i)^{1-\varepsilon_w} \ di\right)^{\frac{1}{1-\varepsilon_w}}$$

$$W_{N,t}(h) = \left(\int_0^1 W_{N,t}(i)^{1-\varepsilon_N^w} \ di\right)^{\frac{1}{1-\varepsilon_w}}$$

for domestically produced tradable goods and non-traded goods, respectively. Finally, the aggregate wage index, W_t, is given by

$$W_t(h) = \left[(\psi)\left(W_{T,t}(h)\right)^{\frac{v}{1+v}} + (1-\psi)\left(W_{N,t}(h)\right)^{\frac{v}{1+v}}\right]^{\frac{1+v}{v}} \tag{13}$$

[14] This case corresponds to a "reverse CES" labour allocation. That is, it generates labour indifference curves concave to the origin and a utility function convex in labour.

Each non-restricted household faces the following budget constraint:

$$P_t C_t^{\circ}(h) + \frac{B_{t+1}(h)}{R_t} = B_t + W_{J,t}(h) L_{J,t}(h) + \Pi_t + T_t \tag{14}$$

At the begining of the period he/she receives labour income, $W_{J,t} L_{J,t}$, where $W_{J,t}$ denotes the sectoral nominal wage, and $L_{J,t}$ the amount of hours devoted to work at sector J. The non-restricted households have access to an international riskless bond, B_{t+1}. R_t is the gross interest rate of the bond held at the end of period t. Finally, the households receive the dividend from the firms, Π_t, and lump-sump transfers, T_t.

Under these assumptions, the household maximisation of (2) subject to (14) leads to the following optimality conditions for consumption/saving and labour supply:

$$\frac{W_{T,t}(h)}{P_t} = \kappa \frac{L_t^{\chi}(h)}{\lambda_t} \left(\frac{\psi L_t(h)}{L_{T,t}(h)} \right)^{1+v} \tag{15}$$

$$\frac{W_{N,t}(h)}{P_t} = \kappa \frac{L_t^{\chi}(h)}{\lambda_t} \left(\frac{\psi L_t(h)}{L_{N,t}(h)} \right)^{1+v} \tag{16}$$

$$\lambda_t \ e_t = \beta E_t \{ \lambda_{t+1} e_{t+1} R_t \}, \tag{17}$$

where λ_t is the marginal utility of the consumption index C_t° (i.e. the Lagrange multiplier of the budget constraint) and is given by:

$$P_t \ \lambda_t \ = \left(\frac{C_t^{\circ}}{C_{t-1}^{h\circ}} \right)^{-\sigma} \tag{18}$$

Sticky wages

As in Erceg, Henderson and Levin (2000), each period only a fraction $1-\theta_w^J$ of households working at sector J reset their nominal wage. Let $\widetilde{W}_{J,t}$ denote the sector $J's$ newly set wage at time t, in nominal terms. Until the next reoptimisation, that wage is adjusted automatically each period according to the indexation rule:

$$\widetilde{W}_{Jt,t+k} = \widetilde{W}_{Jt,t+k-1} \ \eta_{J,t+k}^w$$

for $j = 1, 2, ..,$ where $\eta_{J,t+k}^w$ is the wage indexation rate which we assume to be a function of last period country inflation. By forward iteration we obtain:

$$\widetilde{W}_{J,t,t+k} = \widetilde{W}_{J,t} \prod_{s=1}^{k} \eta_{J,t+k}^w = X_{J,tk}^w \ \widetilde{W}_{J,t} \tag{19}$$

where $X_{J,tk}^w = (\prod_{s=1}^k \eta_{J,t+k}^w)$.

The wage setting problem consists of choosing the wage $\widetilde{W}_{J,t}$ that maximises the expected discounted stream of utility, $E_0 \sum_{t=0}^{\infty} \beta^t \, U(C_t^{\circ}, L_t(h))$, subject to a sequence of period budget constraints (14), and the labour demand

$$L_{J,t+j}(h) = \left(\frac{\widetilde{W}_{J,t}}{W_{J,t+k}(h)} \right)^{-\varepsilon_w} L_{J,t+k} \ . \tag{20}$$

Hence, when optimising, households will set the nominal wage $\widetilde{W}_{J,t}$ according to:

$$E_t \sum_{k=0}^{\infty} (\beta \theta_w^J)^k \ L_{J,t+k}(h) \lambda_{t,t+k} \left(\frac{\widetilde{W}_{J,t} X_{J,tk}}{P_{t+k}} + \frac{\varepsilon_w}{\varepsilon_w - 1} \ MRS_{J,t,t+k}(j) \right) = 0 \ , \tag{21}$$

where $MRS_{J,t,t+k}(h) = -\frac{U_{L_{J,t+k}}}{\lambda_{t,t+k}}$. It is straightforward to see that, under flexible wages, i.e. $\theta_w^J \to 0$, then the previous expression yields the following (standard) static labour supply schedule. The law of motion for the aggregate wage index is given by:

$$W_{J,t} = \left[\theta_w^J \left(\eta_{J,t}^w W_{J,t-1} \right)^{1-\varepsilon_w^J} + (1-\theta_w^J) \left(\widetilde{W}_t^J \right)^{1-\varepsilon_w^J} \right]^{\frac{1}{1-\varepsilon_w^J}} \ . \tag{22}$$

2. Rule-of-thumb households

Rule-of-thumb households do not borrow or save, possibly because of lack of access to financial markets or (continuously) binding borrowing constraints. As a result, they cannot smooth their consumption path in the face of fluctuations in labour income or intertemporally substitute in response to changes in interest rates. Their period utility is the same as the ricardian consumers, and the only difference in their budget constreint is that these consumers have no access to financial markets and do not pay taxes, hence they face a static and simple budget constraint:

$$P_t C_t^r = W_t L_t^r \ . \tag{23}$$

As was the case for optimising households, hours L_t^r are determined by firms' labour demand, and are thus not chosen optimally by each household given the wage. Accordingly, the level of consumption will equate labour income, i.e.

$$C_t^r = \frac{W_t}{P_t} \ L_t^r \ . \tag{24}$$

Finally, given the wage, each firm decides how much labour to hire, and allocates its labour demand uniformly across households, irrespective of their type. Accordingly, we have $L_t^r = L_t = L_t^{TOTAL}$ for all t .

Firms

We assume the existence of a continuum of monopolistically competitive firms producing differentiated intermediate goods inside each sector. Each intermediate firm in the traded goods sectors produces a variety, $y_t^T(j)$, that can be sold at home or in the Union as a consumption good:

$$Y_{T,t}(j) = C_{H,t}(j) + C^*_{H,t}(j) \ , \tag{25}$$

where $C_{H,t}$ represents the domestic demand of domestically produced traded consumption goods and $C^*_{H,t}$ represents the foreign demand of domestically produced consumption, i.e. it represents the country exports. Each intermediate firm in the non-traded goods sector produces a variety, $Y_{N,t}(j)$, that can be sold at home as a consumption good:

$$Y_{N,t}(j) = C_{N,t}(j) + C_{N,t} \ , \tag{26}$$

where $C_{N,t}$ represents the domestic demand of domestically produced non-traded consumption goods and $C_{N,t}$ is an exogenous autonomous demand of shock affecting only the non-tradable sector. In both sectors, the production function is given by

$$Y_{J,t}(j) = A_{J,t} L_{J,t}^{1-\alpha_J}(j) \ , \tag{27}$$

where $A_{J,t}$ is a labour augmenting total factor productivity and $1 - \alpha_J$ is the elasticity of value added with respect to labour, for $J = T, N$, respectively.

In both sectors, each firm j will use a specific labour, $L_{J,t}(j)$. These firms choose the amount of labour in perfectly competitive factor markets. Hence, it chooses the amount of labour $L_{J,t}(j)$ to minimise total costs, $mc_{J,t}(j)Y_{J,t}(j)$, where $mc_{J,t}(j)$ is the real marginal cost. Notice that, given cost minimisation, the firms of each sector will take the marginal costs as given when choosing output price. Formally, it follows that the demand for labour in the non-traded goods sector

$$mc_{N,t}(j) \frac{\partial Y_{N,t}(j)}{\partial L_{N,t}(j)} = \frac{W_{N,t}}{P_{N,t}(j)} \tag{28}$$

as well as

$$mc_{T,t}(j) \frac{\partial Y_{T,t}(j)}{\partial L_{T,t}(j)} = \frac{W_{T,t}}{P_{H,t}(j)} \ . \tag{29}$$

Price setting

We will not allow for *price discrimination between domestically consumed and exported tradable goods*, i.e. $P_H = P_H^*$. Hence, each firm j in the tradable sector is able to set the same price[15]

$$P_{H,t}(j) = \left(\frac{\varepsilon_H}{\varepsilon - 1} \right) mc_{T,t}(j) \ . \tag{30}$$

Finally, each firm j in the non-tradable sector sets prices as follows:

$$1 = \left(\frac{\varepsilon_N}{\varepsilon_N - 1} \right) mc_{N,t}(j) \ . \tag{31}$$

[15] Notice that the markup is defined as the inverse of the *real* marginal cost (e.g. Rotemberg and Woodford (1999))

We now discuss the importance of price stickiness to model changes in observed markups.

Sticky prices

Intermediate firms are assumed to set nominal prices in a staggered fashion, according to the stochastic time dependent rule proposed by Calvo (1983). Each firm resets its price with probability $1-\theta_p^J$ each period, irrespective of the time elapsed since the last adjustment.

Indexation. Consider a firm of sector J which last set its price $\widetilde{P}_{J,t}$ at time t. The price accruing to that firm at time $t+j$ (before the next reoptimisation) is given by $\widetilde{P}_{t,t+j}$ which satisfies the following general indexation rule:

$$\widetilde{P}_{J,t,t+j} = \widetilde{P}_{J,t,t+j-1}\eta^p_{J,t+j} \ ,$$

for $j = 1, 2, ..,$ where η^p_{t+j} is the price adjustment rate (indexation clause) which we assume to be a function of variables observed at time $t+j$. By forward iteration we obtain:

$$\widetilde{P}_{J,t,t+j} = \widetilde{P}_{J,t}\prod_{k=1}^{j}\eta^p_{J,t+k} = X^p_{J,tk}\ \widetilde{P}_{J,t} \ ,$$

where we define $X^p_{J,tk} = \prod_{s=1}^{k}\eta_{J,t+k}$.

The previous specification allows us to distinguish between partial or full indexation on past country-specific (aggregate) inflation (i.e. $(\eta_{J,t} = \frac{P_{t-1}}{P_{t-2}})$.

Optimal price In general, a firm resetting its price in period t will seek to maximise[16]

$$\max_{\{\widetilde{P}_t^J\}} E_t\sum_{k=0}^{\infty}\left(\theta_p^J\right)^k \ E_t\left\{\Lambda_{t,t+k}\ Y_{J,t+k}(j)\ \left(X_{tk}(1+\tau_{J,p})\widetilde{P}_{J,t} - P_{J,t+k}\ MC_{J,t+k}\right)\right\}$$

subject to the sequence of demand constraints, $Y_{J,t+k}(j) = \left(\frac{X_{tk}\widetilde{P}_{J,t}}{P_{J,t+k}}\right)^{-\varepsilon_J}\ Y_{J,t+k}$, where $\widetilde{P}_{J,t}$ represents the price chosen by firms resetting prices at time t, and $(1+\tau_{J,p})$ is a sector-specific, subsidy factor. The first order conditions for this problem are:

$$\sum_{k=0}^{\infty}\left(\theta_p^J\right)^k \ E_t\left\{\Lambda_{t,t+k}\ Y_{J,t+k}(j)\ \left(X_{tk}(1+\tau_{J,p})\widetilde{P}_{J,t} - \frac{\varepsilon_J}{\varepsilon_J-1}\ P_{J,t+k}\ MC_{J,t+k}\right)\right\} = 0 \ . \quad (32)$$

Finally, the equation describing the dynamics for the aggregate price level is given by

$$P_{J,t} = \left[\theta_p^J\ \left(\eta_{J,t}P_{J,t-1}\right)^{1-\varepsilon_J} + (1-\theta_p^J)\ \left(\widetilde{P}_{J,t}\right)^{1-\varepsilon_J}\right]^{\frac{1}{1-\varepsilon_J}} \ . \quad (33)$$

[16] The stochastic discount factor, $\Lambda_{t,t+k}$, is the ratio of the marginal rate of an additional monetary unit $t+k$ periods ahead relative to the marginal utility on an additional monetary unit today. This is treated as exogenous by the firms, and as we will show later is related to the marginal utility of consumption, $\Lambda_{t,t+k} = \beta^k\frac{U_{C_{t+k}}}{U_{C_t}}$.

Aggregation

In a symmetric equilibrium all firms will set the same price inside each sector. In addition, we define aggregate output as follows

$$Y_t = Y_{T,t} + Y_{N,t} \ . \tag{34}$$

Aggregate consumption and hours are given by a weighted average of the corresponding variables for each consumer type. Formally:

$$C_t^{TOTAL} \equiv \lambda \ C_t^r + (1 - \lambda) \ C_t^o \tag{35}$$

$$L_t^{TOTAL} \equiv \lambda L_t^r + (1 - \lambda) L_t^o \tag{36}$$

In addition, the GDP deflator can be obtained as follows

$$P_t^Y = \frac{P_{H,t} Y_{T,t} + P_{N,t} Y_{N,t}}{Y_t} \tag{37}$$

Finally, the nominal exports

$$P_t N X_t = P_{H,t} C_{H,t}^* - P_{F,t} C_{F,t} \tag{38}$$

Monetary policy

The central bank sets the nominal interest rate so as to respond to deviations of output, inflation and money growth from their steady-state values according to the expression:

$$\ln(R_t/R) = \rho_\pi \{ n \ln(\pi_t) + (1 - n) \ln(\pi_t^*) \} + \varepsilon_{r_t} \tag{39}$$

where ε_{r_t} represents a monetary policy shock.

Table 2.1. Inflation accounting of selected countries (1999-2003)

	Final demand deflator (Contributions to change)			GDP deflator (Contributions to change)				
	Total (%)	Domestic	Imports	Total (%)	Wages	Productivity	Markups	Taxes
EMU	1.85	1.50	0.36	2.03	1.42	-0.31	0.69	0.23
			Deviations from EMU average					
GR	1.48	1.16	0.32	1.45	2.69	-1.96	0.25	0.48
ES	1.33	1.26	0.07	1.78	0.89	-0.12	0.71	0.31
IE	1.16	0.63	0.53	2.08	2.06	-1.80	1.52	0.29
NL	0.10	-0.09	0.19	1.40	1.11	0.16	-0.20	0.33
PT	0.58	0.62	-0.04	1.66	1.61	0.13	-0.55	0.47

Table 2.2. Spanish inflation differentials: 1999-2003 $(\pi_t - \pi_t^*)$

Inflation differential (1)+(2)	Tradables Total (1)	Wages (a)	Product. (b)	Markups (c)	Dual inflation Total (2)	Wages (a)	Product. (b)	Markups (c)
1.2	0.8	0.4	-0.1	0.3	0.4	0.1	0.4	0.7

Note: The inflation differential between Spain and the Euro zone can be written as follows:

$$\pi_t - \pi_t^* = TRADABLE_t + DUAL_t$$

where $TRADABLE_t$ represents the differences in the inflation of tradable goods, that can be decomposed as de sum of the differences in wages (w), markups (μ) minus relative productivities (x):

$$TRADABLE_t = (\pi_{T,t} - \pi_{T,t}^*) = (\Delta\mu_{T,t} - \Delta\mu_{T,t}^*) + (\Delta w_{T,t} - \Delta w_{T,t}^*) - (\Delta x_{T,t} - \Delta x_{T,t}^*)$$

while $DUAL_t$ represent the contribution of the differences between dual inflations, that can also be decomposed as follows

$$\begin{aligned} DUAL_t \;=\; & (1-\alpha)\theta[(\Delta w_{N,t} - \Delta w_{T,t}) - (\Delta w_{N,t}^* - \Delta w_{T,t}^*)] \\ & -(1-\alpha)\theta[(\Delta x_{N,t} - \Delta x_{T,t}) - (\Delta x_{N,t}^* - \Delta x_{T,t}^*)] \\ & +(1-\alpha)\theta[(\Delta\mu_{N,t} - \Delta\mu_{T,t}) - (\Delta\mu_{N,t}^* - \Delta\mu_{T,t}^*)] \end{aligned}$$

plus an additional and negligible term that will capture fluctuations in the terms of trade, where α represents the share of imported goods in total consumption and θ is the share of private consumption of nontradables to the total private consumption minus imported consumption. See Estrada et al. (2004) for details. Finally, all the numbers represent average annual rate of growth in percentage points. According to the previous expressions, it is straightfroward to see that the columns (1) and (2) have been obtained as (a)-(b)+(c).

Table 3.1. Parameter Values

β	Discount factor	0.99
χ	Inverse of labour supply elasticity	1
σ	Intertemporal elast.of substitution	1
η	Consumption habits	0.7
ϕ	Share of of C_H on C_T	0.5
ρ	Elast. of subst. between C_T and C_N	0.44
ξ	Elast. of subst. between C_H and C_F	1.5
υ	Elast. of subst. between L_T and L_N	-1
$\gamma = \psi$	Share of of C_T on C or Share of of L_T on L	0.5
ϕ	Share of of C_H on C_T	0.75
ϕ^*	Share of of C_H^* on C_T^*	0.20
α_N	Output elasticity to hours in sector N	0.7
α_T	Output elasticity to hours in sector T	0.7
ϵ_p	Elast.of subst. across goods within the sector	11
ϵ_w	Elast.of subst. across labour within the sector	21
θ_p^N	Prob. of not resetting price at t in sector N	0.65
θ_p^T	Prob. of not resetting price at t in sector T	0.65
θ_w^N	Prob. of not resetting wages at t in sector N	0.75
θ_w^T	Prob. of not resetting price at t in sector T	0.75
$\delta_H^p = \delta_N^p$	Sectoral price index. to own country inflation	1.0
$\delta_F^p = \delta_{N*}^p$	Sectoral price index. to own country inflation	1.0
$\delta_T^w = \delta_N^w$	Sectoral wage indexation to own country inflation	0.8
$\delta_{T*}^w = \delta_{N*}^w$	Sectoral wage indexation to own country inflation	0.4
ϕ_π	Inflation weight in the monetary policy rule	1.5
n	Weight of domestic inflation in the rule	0.1
ρ_r	Autocorrelation monetary policy shock	0.9
ρ_a	Autocorrelation of technology shocks	0.9
ρ_e	Autocorrelation of preferences shocks	0.9
ρ_N	Autocorrelation of non-tradable demand	0.9

Table 3.2. Inflation Differentials

Source of Fluctuations	*Maximum Inflation Diff.*		*Accumulated at* 3 years *InflationDifferentials*		
	Horizon	Value	$\{\pi_H\text{-}\pi_F\}$	$\{\pi_N\text{-}\pi_H\}$	$\{\pi\text{-}\pi^*\}$
Area-Wide M. Policy	2	0.004	0.002	-1.270	0.080
Home Country Shocks					
Aggregate Tech	2	-0.630	-0.510	-1.330	-1.24
Sectoral Tech	2	-0.150	-1.690	2.240	-0.32
Agg. Cons/Preference	2	0.270	0.420	-0.370	1.10
Sectoral Consumption Non-Tradable Goods	2	0.140	0.101	0.44	0.52

Note: All shocks have been normalised so as to generate a 1% impact effect on output.

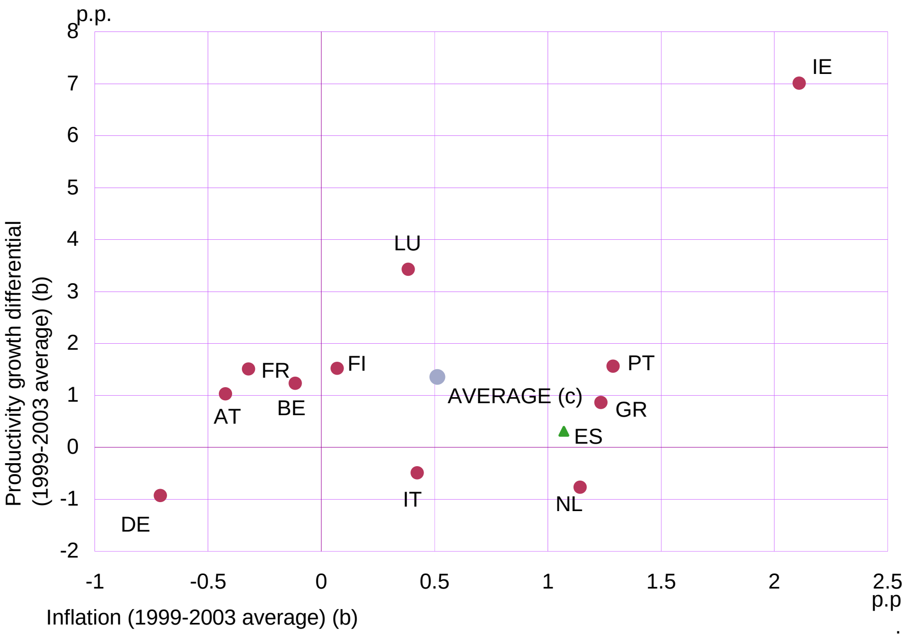
Table 3.3. Sensitivity Analysis

	Monetary Policy			*Preferences*			*Demand for Non-Tradables*		
	$\{\pi_H$-$\pi_F\}$	$\{\pi_N$-$\pi_H\}$	$\{\pi$-$\pi^*\}$	$\{\pi_H$-$\pi_F\}$	$\{\pi_N$-$\pi_H\}$	$\{\pi$-$\pi^*\}$	$\{\pi_H$-$\pi_F\}$	$\{\pi_N$-$\pi_H\}$	$\{\pi$-$\pi^*\}$
1	0.18	-1.32	0.61	1.00	-0.37	1.35	0.27	0.44	0.60
2	0.01	-0.43	0.54	0.45	0.26	1.28	0.09	0.60	0.54
3	0.14	-1.27	0.29	0.54	-0.33	1.11	0.12	0.42	0.46

Note: Case 1: No price indexation in the foreign economy. Case 2: Case 1 plus price indexation in the domestic economy only in non-tradable goods sector. Case 3: No price indexation at home and abroad. Simulations based upon the model with rule-of-thumb consumers.

INFLATION AND SECTORAL PRODUCTIVITY DIFFERENTIALS (a)

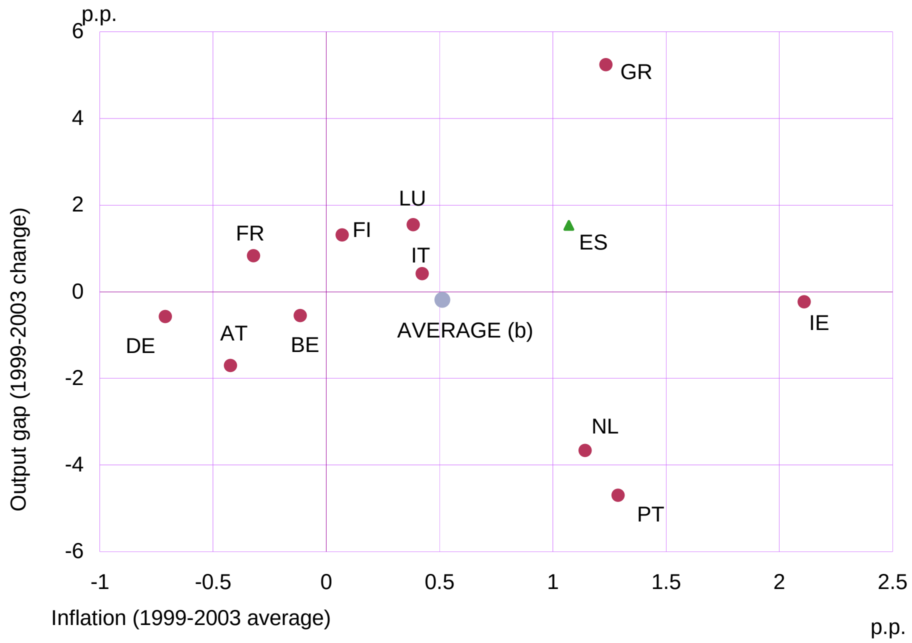
CHART 2.1



SOURCES: Eurostat and national statistics.

a. Productivity growth differential between the manufacturing sector and the market services sector.
b. Differential with respect to EMU.
c. Simple arithmetic average of the twelve countries data.

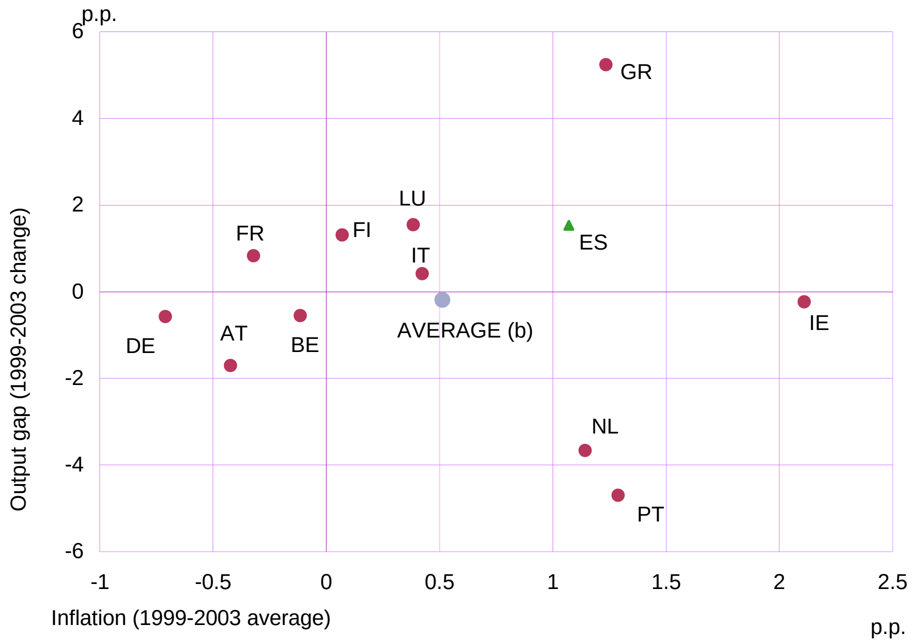
INFLATION AND OUTPUT GAP (a) **CHART 2.2**



SOURCES: Eurostat and OECD.

a. Differentials with respect to EMU.
b. Simple arithmetic average of the twelve countries data.

INFLATION AND OUTPUT GAP (a) **CHART 2.2**

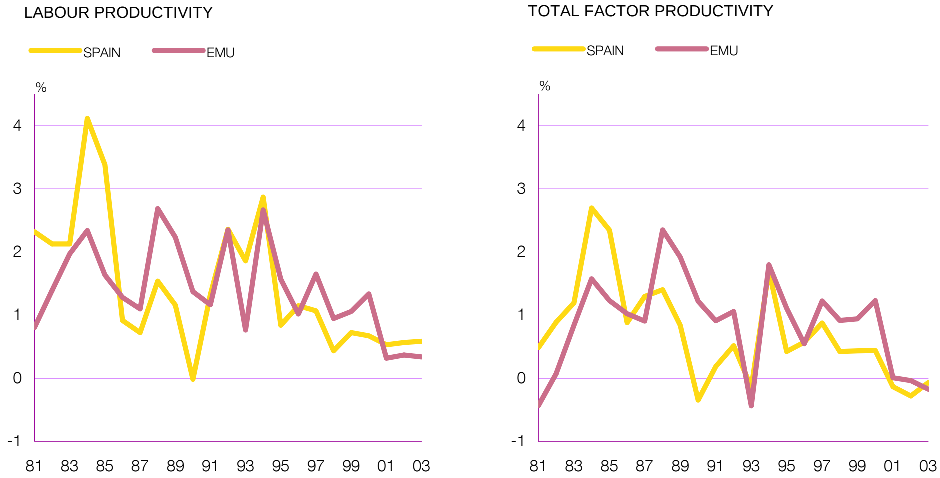


SOURCES: Eurostat and OECD.

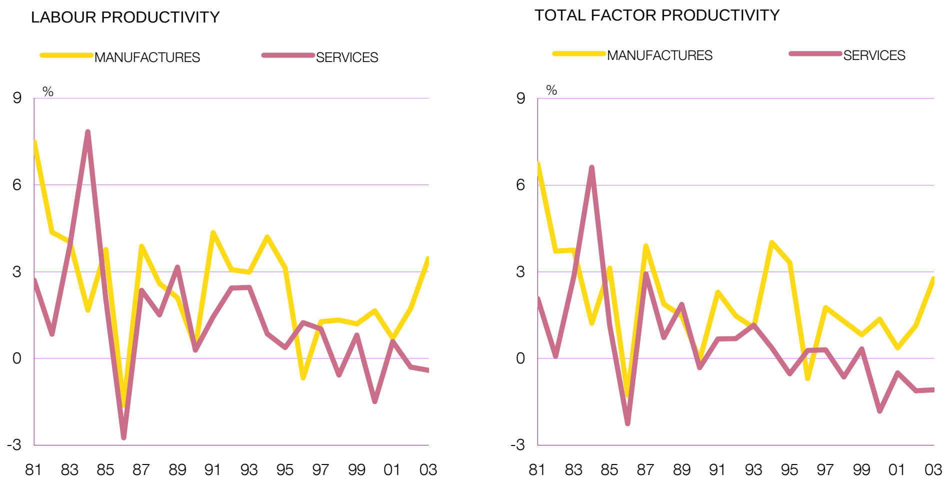
a. Differentials with respect to EMU.
b. Simple arithmetic average of the twelve countries data.

PRODUCTIVITY GROWTH

CHART 2.4



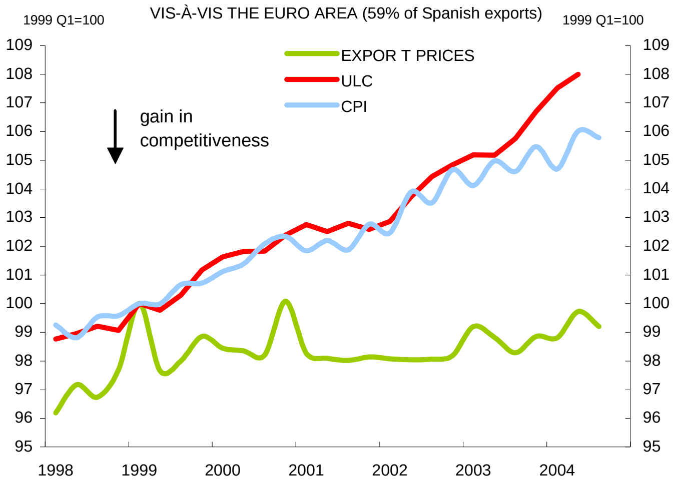
SECTORAL EVIDENCE FOR SPAIN



SOURCES:European Comission and Banco de España.

CHART 2.5

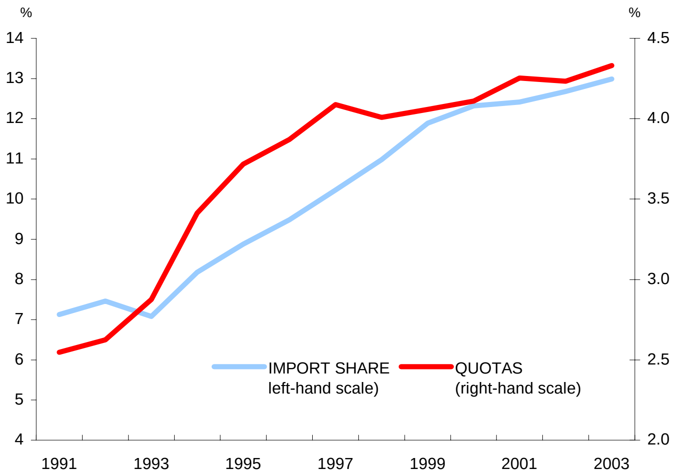
Spanish Competitiveness: relative consumer prices, export prices and unit labour costs (a)



Source: Bank of Spain
(a) An increase in the index denotes a loss of competitiveness, a decrease a gain.

CHART 2.6

Real export quotas in the EA and real import share in final demand

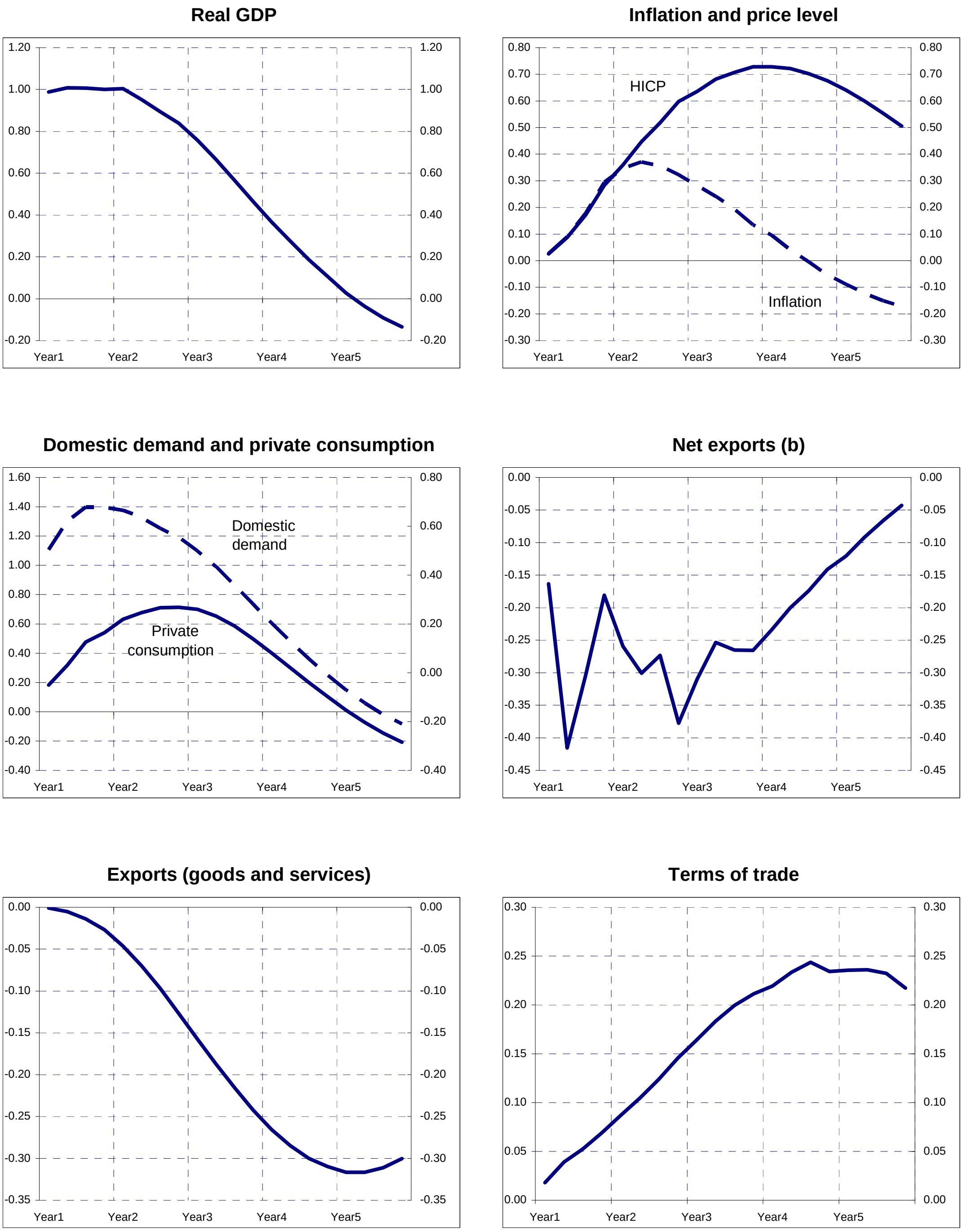


Sources: National Bureau of Statistics and Customs, Spanish Treasury, and IMF.

CHART 2.7

Government expenditure shock (a)

Percentage changes from baseline levels



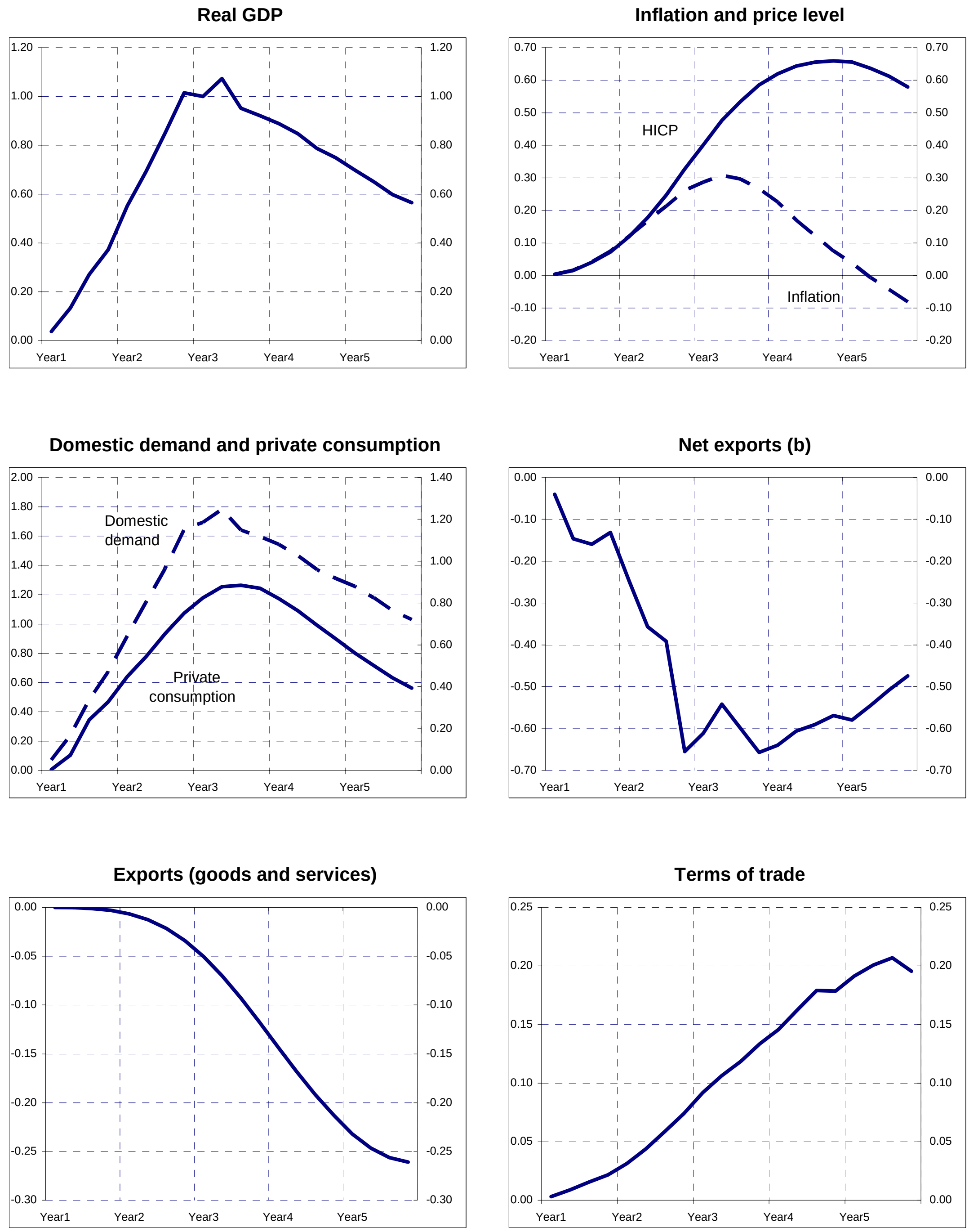
(a) Simulations obtained from the Quarterly Macroeconometric Model of BE.

(b) Contributions to GDP growth

CHART 2.8

A monetary policy shock (a)

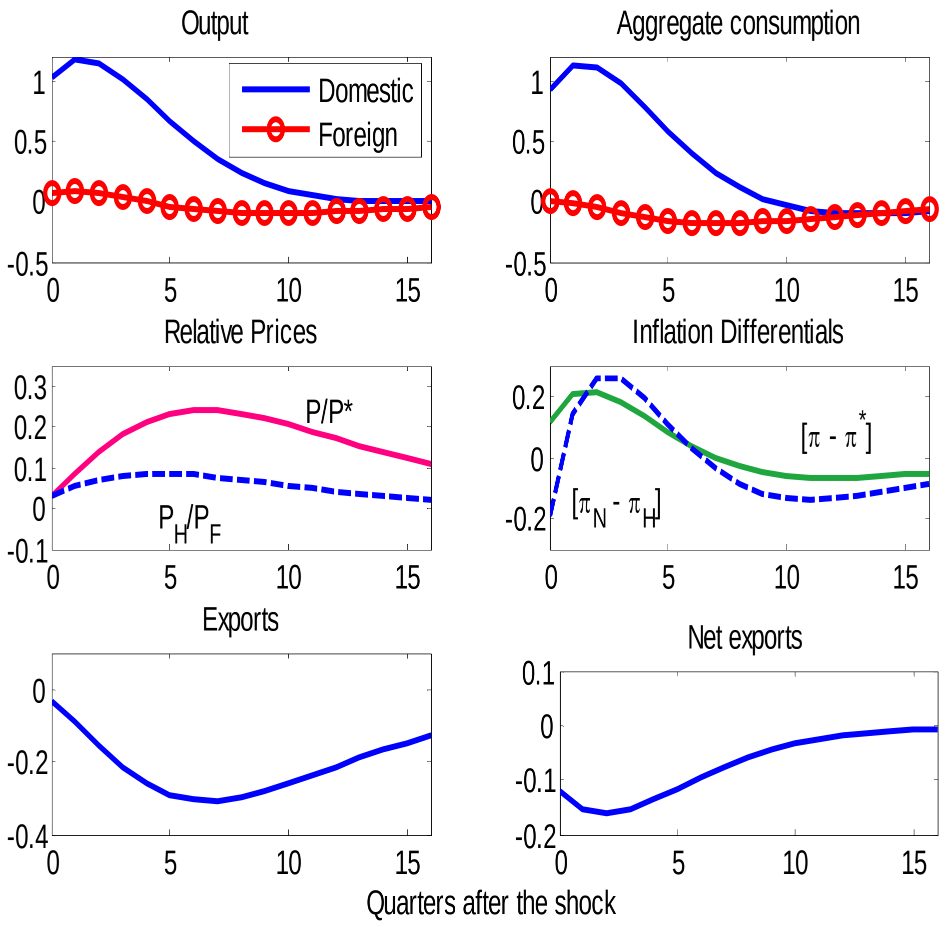
Percentage changes from baseline levels



(a) Simulations obtained from the Quarterly Macroeconometric Model of BE.

(b) Contributions to GDP growth

CHART 3.1: Dynamic responses to a composite demand shock in domestic economy



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