Staying Together or Drifting Apart: Inflation Targeting and Fiscal Policy in an Estimated Euro Area Model with Sticky Prices and Sticky Wages

[Preliminary]

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Abstract

Five years after the launch of third stage EMU the convergence in macroeconomic aggregates has stopped. In particular the wedges in inflation rates between the individual member states are more persistent compared to other currency areas (Angeloni, Ehrmann (2004)). We report evidence that the persistent dispersion in macroeconomic aggregates can be traced back to a combination of structural differences in the degrees of inflation persistence, habit formations and asymmetric shocks. We show by sensitivity analysis that under a broad set of assumptions fiscal policy is likely to improve economic welfare.

Key Words: Euro area, inflation differentials, monetary policy, fiscal policy and minimum distance estimation.

JEL Classification Numbers: C51, E32, E52, F31.

1 Introduction

The pre-Maastricht era in the 1990's was characterised by a long period of conversion in macroeconomic aggregates. Mediteranian countries like Greece, Italy, Portugal and Spain were moving from six to seven or even double digit numbers in inflation rates in 1991 to the lower German and French levels within seven years. The convergence process was driven by stringent rules as laid out in the Treaty of Maastricht that called the Maastricht criteria to be met in order to become a member of the monetary union which was supposed to lunch in 1999 by then.

Five years after its start the process of convergence has stopped. In particular compared to other currency areas the euro-area prevails a higher degree of persistence in inflation differentials (see Angeloni, Ehrmann (2004)). Within this paper we show that these stylised facts are likely to be intrinsic to the current macroeconomic design of the euro-area. With the launch of third stage EMU the individual member countries have rendered monetary sovereignty to the common European Central Bank (ECB). The ECB targets to keep the harmonised consumer price index (HCPI) close to but under two percent. Importantly the ECB is supposed to have a Euro-Tower perspective as it should be indifferent against mean preserving distributions of macroeconomic outcomes across the currency area. In contrast labour unions and in particular governments basically focus on national aggregates. This constellation calls for stringent rules which balance the chances and perils that are nested in monetary and fiscal policy interaction with decentralised fiscal authorities (Dixit, Lambertini, 2003). The design of fiscal policy was heavily shaped by the "Delors Report" that called for stringent rules for national fiscal policies as a perquisite for an efficient functioning of a monetary union (Bofinger 2003). Therefore the grandfathers of the SGP intended to design fiscal rules that prevented fiscal authorities itself from being a major source of economic disturbances. This was laid down in particular by the three percent deficit criterion which was intended to serve as a firewall against myopic fiscal policymakers. Although evidence is reported that fiscal policy is mildly anticyclical at the European level (see Gali, Perotti (2003)) a central fiscal authority that uses the cyclically adjusted balance to smooth the business cycle is not existent.

We show that the observed dispersion in macroeconomic aggregates across the currency area is likely to be explained by a combination of asymmetric shocks and differences in the underlying structures of the economies in conjunction with a too cautious use of the fiscal instrument. It is well known that a currency area is vulnerable to idiosyncratic shocks if fiscal policy is not conducted in an anticyclical fashion (Torben, M.A, (2003)).

Related studies are Angeloni and Ehrmann (2004) who explain persistent inflation differentials by structural differences in the economies. They come to the conclusion that the main force in driving persistent wedges between national inflation rates can be traced back to the inflation persistence nested in national Phillips curves. Honohan and Lane (2003) come to the conclusion that the main source of divergence is the different impact of real exchange rates on the individual member countries.

The paper is structured as follows: In sections two and three we derive and estimate an asymmetric euro-area model which consists of two blocs, which we assign 75% and 25% of GDP mass respectively. This additional source of asymmetry allows us to analyse the effects of asymmetric shocks emerging from non-trivial but minor parts of the union. The applied estimator matches the theoretical and empirical sample autocorrelation functions by minimising an Euclidean norm of the most recent quarterly euro-area data (1983-2003). Given this rich set up we aim at identifying the sources that are most likely to let a currency area drift apart. Through symmetric and asymmetric impulse response analysis we analyze in a model with sticky prices and sticky wages the interaction between these two blocs and the implied economic mechanisms. We offer a theory that explains the observed macroeconomic divergence. We will give a description of those forces that keep the union together versus those forces that potentially drive it apart. Most prominently from a macroeconomic perspective the effects of diverging real interest rates and intra-European competitiveness always work in opposite directions. We find evidence that asymmetric shocks create a high degree of mismatch between the state of the cycle in individual member countries and the imposed montary conditions set by the ECB.

In the final part of the paper we analyse under which scenarios monetary and fiscal stabilisation policy dominates a strategy of monetary policy only. We perform sensitivity analysis with respect to the variances and covariances of shocks and to structural features of the economies. We come to the conclusion that under a broad set of alternative assumptions on the structure of the economy the use of fiscal policy can reduce the loss imposed on the social planer. We hold the belief that the mainspring of persistent differentials is rooted in a badly designed macroeconomic architecture that uses the fiscal instrument too cautiously. It prevails that a monetary union calls for a renaissance of fiscal policy from a stabilisation perspective.

2 The Model

In this section we introduce an asymmetric two-country model that we fit to quarterly data of the euro-area over the most recent period (1983-2003). The model is New Keynesian in spirit as it shares the following building blocs:

- A hybrid New Keynesian Phillips curve depicting the pricing decisions of monopolistically competitive firms in the intermediate good sector.
- A hybrid New Keynesian wage-adjustment equation depicting the wage dynamics if wages are neither perfectly flexible nor perfect substitutes for the input decisions of firms.
- An intertemporal IS-equation depicting the optimal allocation schemes of households allocating consumption and bond holdings over time.
- And the policy rules that tell us how monetary and fiscal policy is conducted.

As we do not restrict attention to the case of a symmetric two bloc model we are able to identify the impact of asymmetries in the Phillips curve and the IS-equation and its role for the business-cycle and the persistence in dispersion in macroeconomic aggregates across the currency area. We assume that one bloc of the currency area has a GDP mass of 75% whereas the rest counts for 25% in terms of GDP.

2.1 The New Keynesian Phillips Curve

The cornerstone of New Keynesian Models is the New Keynesian Phillips curve (NKPC) (e.g. Sbordone (2001)). The New Keynesian Phillips curve relates some measure of economic activity to the inflation rate. Hence it gives a description of the supply side of the economy. In the following we will shortly discuss a derivation of the Hybrid New Keynesian Phillips curve. In particular we will stress that non-optimising firms are essential to generate the persistence nested in macroeconomic time series as purely forward-looking versions of the NKPC do not imply sufficient inertia. The most popular foundation of price-stickiness relies on the black-box approach of Calvo-pricing. Calvo (1983) assumed that each period only a fraction $\left(1-q_p\right)$ of firms have the opportunity to reset prices optimally. The price change signal follows a time dependent Poisson Process. Those firms that receive the price change signal will choose their new price in order to maximise expected profits. While choosing the reset price they will take in particular into account the probability of being stuck with the new reset price for j periods to come. The firm solves its cost minimisation problem subject to the production function:

$$Y(i,j)=A(h_t)\bar{K}^{d}\left\{\left[\int_0^1 N(i,j)^{\frac{f-1}{f}}\,dj\right]^{\frac{f}{f-1}}\right\}^{1-d} \tag{2.1.1}$$

where Y(i,j) denotes the output of firm i that hires labour type j. The parameter d denotes the capital share of the economy and f depicts the elasticity of substitution between the different kinds of labour. While maximising expected profits the individual firm in the intermediate good sector takes wages and prices as given:

$$W_t=\left[\int_0^1 W(j)^{1-f}\,dj\right]^{(1/(1-f))} \tag{2.1.2}$$

$$P_t=\left[\int_0^1 p_{j,t}^{1-q}\,dj\right]^{(1/1-q)}. \tag{2.1.3}$$

The conventional factor demand equation can be stated as follows:

$$N(i,j)=\left(\frac{w(i,j)}{W}\right)^{-f}Y(i,j)^{(1/1-f)} \tag{2.1.4}$$

N(i,j) denotes the demand of labour j by firm i at time t. Given that each period only a fraction of firms is visited by the „Calvo ferry“ there is a probability of being stuck with the old price with a probability of q_p. Henceforth the expected profit for the time interval until which the firm is allowed to reoptimize can then be stated as follows:

$$\sum_{t=0}^{\infty} q_p^{t}\left\{\left[\frac{P(i,j)}{P}-MC(i,j)\right]Y(i)\right\}, \tag{2.1.5}$$

In a symmetric equilibrium the law of motion will be given by the following weighted average of those agents that optimize (P*) and those agents that do not optimise (P).

$$P_t=\left[q_pP^{1-e}+\left(1-q_pP^{*1-e}\right)\right]^{\frac{1}{1-e}}, \tag{2.1.6}$$

where we assume that those agents that are not called upon to reset prices optimally simply index their prices partially by last periods inflation rate, with $w\in[0,1]$:

$$P_{j,t}=wp_{t-1}P_{j\,t-1} \tag{2.1.7}$$

Obviously the microeconomic foundations for Calvo-pricing and rule-of-thumb setters are somewhat weak. Nevertheless rule-of-thumb setters have strong arguments on their side as (see Amato, Laubach (2003)):

- Rule of thumb behaviour does not produce any computational costs.
- The fraction of price setters that updates expectations by rule-of-thumb implicitly learns as π_{t-1} incorporates the pricing decisions of those agents that optimised.
- In steady state both types of agents set identical prices.

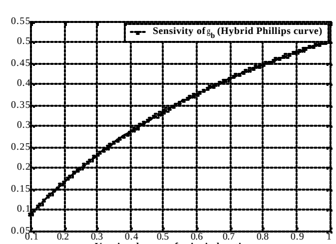
Inserting the first order condition of those agents that are allowed to optimise into the law of motion (2.1.6) and log-linearising around a non-inflationary steady state yields to the following lineraized version of the NKPC (Rabanal, Rubio-Ramirez (2003)).

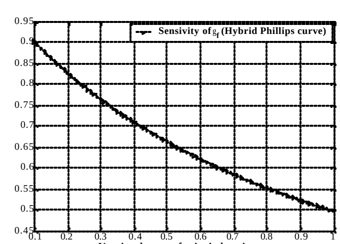
$$\Delta p_t = g_b E_t \Delta p_{t-1} + g_f E_t \Delta p_{t+1} + k_p^{'} \left(mc_t + l_t \right) \qquad (2.1.8)$$

where $k_p = \dfrac{(1-d)(1-bq_p)(1-q_p)}{q_p(1+d(\bar{e}-1))}$, $\bar{e} = \dfrac{\bar{l}}{\bar{l}-1}$, $k_p^{'} = \dfrac{k_p}{1+wb}$, $g_b = \dfrac{w}{1+wb}$, and $g_f = \dfrac{b}{1+wb}$.

The dynamics enshrined in the NKPC crucially depend on two relations. On the one hand on the relative magnitude of g_b in relation to g_f where it holds that: $g_b + g_f = 1$. On the other hand on $k_p^{'}$ which depicts the responsiveness of inflation to deviations of marginal cost from its steady state level. The relative size of g_b in relation to g_f critically determines the persistence of the inflation process. Equation (2.1.8) nests the case of a purely backward looking Phillips curve ($g_b = 1$) as well as the standard NKPC ($g_b = 0$). The higher the degree of backward-lookingness the higher will be the persistence of the inflation process as embedded in the autocorrelation functions. The degree of backward lookingness depends in particular on the degree of price indexation ω (see Figure 1).

Figure 1: The impact of changing indexation w on the degree of backward-lookingness g_b and forward-lookingness g_f .

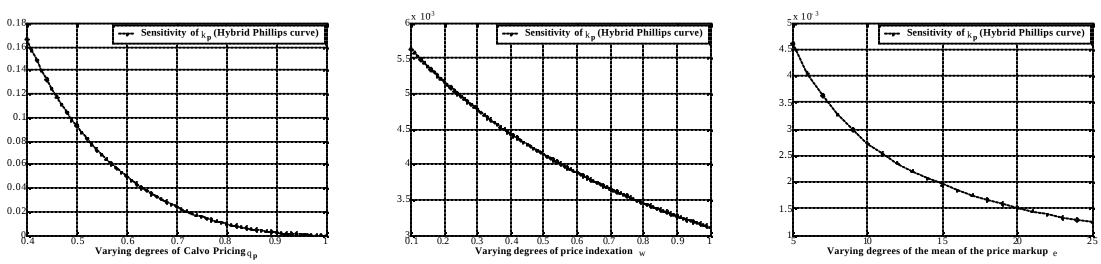




Baseline calibration: β=0.99; coefficients for the large bloc of he currency area.

The second crucial parameter $k_p^{'}$ denotes the sensitivity of inflation with respect to marginal cost and indirectly over the production function to output. Therefore the parameter $k_p^{'}$ can be interpreted as the slope of the Phillips Curve. Note in particular that the parameter $k_p^{'}$ depends negatively on the degree of Calvo-price setters (Figure 2). Hence the more economic agents are able to adjust prices to changing economic conditions the looser becomes the link between changes in the economic cycle and the inflation process itself.

Figure 2: Changes in k_p as a function of q_p, w, $\bar{e}$ and b



Baseline calibration: β=0.99; coefficients for the large bloc of he currency area.

Given the absolute magnitudes of g_b, g_f and $k_p^{'}$ it is easy to see that by far the most important variable in explaining the inflation process is the inflation rate itself and not the deviation of marginal costs from its flex-price equilibrium.

In order to capture the effects of intra-european competitiveness we augment the Phillips curve by imported inflation taking into account that households consume foreign goods. Accordingly the Phillips-curve can be restated including the terms of trade effects as follows (Angeloni, Ehrmann, 2004):

$$\Delta p_{i,t} = g_f E_t \Delta p_{i,t+1} + g_b E_t \Delta p_{i,t-1} + k_p^{'} mc_{i,t} + xp_{-i,t} + l_{i,t} \qquad (2.1.19)$$

2.2 The Optimizing Household

Assume that a representative agent maximises utility according to the following utility function:

$$E_0 \sum_{i=0}^{\infty} b^i U_t \tag{2.2.1}$$

Every household maximises its utility by choosing the following period bundles:

$$\left\{ C_{t+j,} B_{t+j}, (M/P)_{t+j} \ and \ L_{t+j} \right\}$$

Hence households are assumed to maximise utility by choosing the optimal path for consumption, bond holdings, real balances and labour supply. As a functional relationship let us propose the following separable additive period utility function (Smets, Wouters (2003)):

$$U_t = l^{g_t} \left(\frac{1}{1-s_c} \left(C_t - H_t \right)^{1-s_c} \right) - \frac{l_t^w}{1+s_l} l_t^{1+s_l} + \frac{e_t^M}{1-s_m} \left(\frac{M_t}{P_t} \right)^{1-s_m} \tag{2.2.2}$$

Accordingly a household draws utility from his consumption whereas his work effort imposes disutility. $C_{t,j}$ denotes consumption of the aggregate consumption good of household j in period t. Additionally we assume money in utility. The term l_g^t denotes a stochastic shock to common households preferences. As the shock will enter the IS-equation it can be labeled as demand shock. The parameter s_c denotes the intertemporal elasticity of consumption growth with respect to the real interest rate. The elasticity of money holdings is given by s_m. The inverse of the elasticity of labor supply with respect to wages is denoted by s_l. Note by assuming complete contingent claims markets households can insure themselves against any idiosyncratic income risk which stems from the risk of by being employed by firm i. This ensures that the marginal utility of wealth is equalized across households in equilibrium. Households face the following flow budget constraint:

$$\frac{M_t}{P_t} + b \frac{B_t}{P_t} = \frac{M_{t-1}}{P_t} + \frac{B_{t-11}}{P_t} + W(i,j) N(i,j) + \Pi(i,j) + T(i,j) \tag{2.2.3}$$

<u>*Consumption:*</u>

Maximising utility implies in particular that the marginal utility of consumption today and tomorrow should be equalised in equilibrium as consumption smoothing is a prime motive of households decision making. The optimization problem of the representative household can be stated as follows:

$$E_t \left[b \frac{l_{t+1}}{l_t} \frac{R_t}{P_{t+1}} P_t \right] = 1 \tag{2.2.4}$$

Given the utility function it has to hold that the Lagrange multiplier will be given by:

$$l_t = e_t^g \left(C_t - H_t \right)^{-s_c} \tag{2.2.5}$$

As we have complete contingent claims markets households have the possibility to carry their purchasing power through time (Cochrane H. 2003). If you buy $(1/P_t)$ dollars today it will pay off a stochastic return of $r = R_{t+1}(P_{t+1}/P_t)$ dollars tomorrow.

Linearizing the intertemporal Euler equation around a non-inflationary steady state results in to the following hybrid IS-equation:

$$y_{i,t} = \frac{h}{1+h} y_{i,t-1} + \frac{1}{1+h} y_{i,t+1} - \frac{1-h}{(1+h)s_c}\left(i_t - p_{i,t+1}\right) + \frac{1-h}{(1+h)s_c}\left(l_{i,t}^g - l_{i,t+1}^g\right) \quad (2.2.6)$$

Note in particular that the equation nicely depicts (by forward iteration) that today's income depends on the future path of short term interest rates. Hence monetary policy exerts its influence on aggregate demand by setting the future path of short term interest rates. Given nominal inertia monetary policy has a leverage on real short term interest rates. In order to capture the intra-european linkages we augment the hybrid IS-equation by terms of trade effects. If domestically produced goods inflate faster than foreign ones the demand for domestic products will start to decline whereas high foreign inflation fosters the production of domestic goods. Accordingly we can state the IS-equation as follows:

$$y_{i,t} = \frac{h}{1+h} y_{i,t-1} + \frac{1}{1+h} y_{i,t+1} - \frac{1-h}{(1+h)s_c}\left(r_t - \Delta p_{i,t+1}\right) + i\Delta q_{i,,t} + \frac{1-h}{(1+h)s_c}\left(l_{i,t}^g - l_{i,t+1}^g\right) \quad (2.2.7)$$

Labour:

In the flex-price equilibrium it will have to hold that the marginal disutility of labor in relation to the marginal utility of consumption has to be equal to the real wage.

$$V_N = \frac{W_t}{P_t} U_C \qquad (2.2.8)$$

As we deviate from flex-price markets we assume that households have some degree of market power as they supply a differentiated labour input. For the sake of simplicity it is generally assumed that the labour supply decision is analytically very analogous to the pricing decision in the intermediate good markets. Each period only a fraction of households is called upon to reset its wages optimally. The other fraction of households q_W, that do not optimise simply index the wage partially by last periods inflation rate

$$W_t = \left(P_{t-1}/P_{t-2}\right)^a W_{t-1}^a , \qquad (2.2.9)$$

where α denotes the degree of indexation potentially running from $a \in [0,1]$. While maximising utility households face the following labour demand curve

$$l_t^t = \left(\frac{W_t^t}{W_t}\right)^{\left((1+l_{w,t})/l_{w,t}\right)} L_t \quad , \tag{2.2.10}$$

where l_w denotes the elasticity of substitution between different kinds of labor with

$$L_t = \left[\int_0^1 l_t^{t\,1/(1+l_{w,t})} dt\right]^{1+l_{w,t}} \quad . \tag{2.2.11}$$

Making use of the first order condition (2.2.8) that governs the households labour supply decision and evaluating the marginal disutility of labour and consumption until the likely time horizon of the next reset signal occurs results into the following first order condition:

$$\frac{\tilde{w}}{P_t} E_t \sum b^i q_w^i \left(\frac{P_t / P_{t-1}}{P_{t+i} / P_{t+i-1}}\right) \frac{l_{t+1} U_{t+i}^C}{1+l_{w,t+i}} = E_t \sum b^i q_w l_{t+i} V_{t+i}^n \tag{2.2.12}$$

Wage setters will in particular take into account the probability of being stuck with the new reset wage for j periods. Based on this bipolar structure of agents the law of motion can be stated as follows:

$$W_t^{-1/l_{w,t}} = z\left(W_{t-1}\left(\frac{P_{t-1}}{P_{t-2}}\right)^a\right)^{(-1/l_{w,t})} + (1-z)\,\tilde{w}^{-1/l_{w,t}} \tag{2.2.13}$$

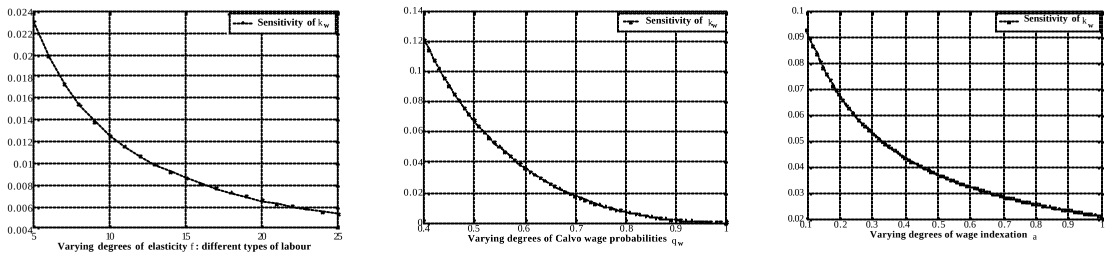
Linearizing the law of motion around its non-inflationary steady state leads to the following hybrid New Keynesian Wage equation (see Rabanal, Rubio-Ramirez (2003)):

$$\Delta w_t - a\Delta p_{t-1} = b\,E_t \Delta w_{t+1} - ab\Delta p_t + k_w\left(mrs_t - (w_t - p_t)\right) \tag{2.2.14}$$

where $k_w = \frac{(1-q_w)(1-bq_w)}{q_w(1+fg)}$.

By far the most important parameter with respect to the model dynamics is k_w. It denotes the responsiveness of wages to output. Note that it is a stylised fact that real wages move mildly procyclical with output (Christiano, Eichenbaum and Evans (2004)). This stylised fact puts important restrictions on the range of plausible parameter values. Assume that the economy is hit by an expansionary monetary shock. Obviously under reasonable assumptions wages and prices will start to accelerate. Nevertheless given that real wages move mildly procyclical with demand shocks this can only be the case if it holds that $k_w > k_p$. Throughout the paper we assume that labour markets are segmented in Europe. Accordingly changing real wages do not trigger labour factor mobility.

Figure 3: The impact of q_w, f a on k_w



Baseline calibration: β=0.99; coefficients for the large bloc of he currency area.

Money demand decision:

Although recursive to the rest of the system one can retrieve the money demand relationship. Remember as we assume that monetary policy is conducted according to the notion of manipulating interest rates the monetary base is endogenously determined and only a reflex of the state of the economic cycle. The demand for cash is given by:

$$e_t^M \left(\frac{M}{P}\right)_t^{-s_m} = \left(C-H\right)_t^{-s_c} - \frac{1}{1+i_t} \qquad (2.2.15)$$

2.3 Monetary Policy

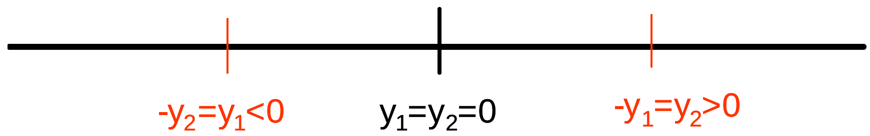
The overall goal of stabilisation policy is to promote economic welfare. This means in particular that consistent with the structural equations of the model the social planer sets a path for its instrument $\{i\}_{\{0,\infty\}}$ consistent with its targets in such a way that the expected utility of the representative household is maximised. A second order approximation of the households utility function at the non-inflationary steady state can be stated as follows (Woodford (2003):

$$\sum_{t=0}^{\infty} b^t U_t = -\Omega \sum_{t=0}^{\infty} L_t + t.i.p + O\|\cdot\|^3 \qquad (2.3.1)$$

with: $L_t = l_p p_t^2 + l_w \Delta w_t^2 + l_y y_t^2 + l_{\Delta i} \Delta i_t^2 + l_{\Delta g} \Delta g_t^2$

Where l_y, l_p, l_w, $l_{\Delta i}$ and $l_{\Delta g}$ depict the respective weights the ECB puts on the individual target variables. In accordance with its legal status we assume that the common central bank targets at keeping the inflation rate close to its inflation target, while equally having a concern for economic activity. Note that the ECB only targets at euro wide averages, whereas it does not take care of the dispersion of goal variables across member states. In other words the ECB does not consider the spread as a problem as long as it is mean preserving.

Figure 4: Mean Preserving Distributions of Macroeconomic Outcomes



This very fact makes a monetary union very vulnerable to asymmetric shocks (Torben, M., A., 2003). Therefore we will argue that the introduction of a social planer that implements its overall desired outcomes by two instruments is likely to have a positive impact on the suffered loss. As we will see in section 5 this conclusion will hold under a broad set of assumptions.

Generally the need for a stabilisation policy in the face of nominal inertia can be explained as follows. As some economic agents simply index prices and wages they are out of their flex-price equilibrium due to nominal inertia. The prices and wages charged are not identical with those they would have charged if they were allowed to reoptimise. Note, as we assume concave preferences it holds for risk averse economic agents that the utility of expected consumption is larger than expected utility.

$$U\left[E(C)\right] > E\left[U(C)\right] \qquad (2.3.2)$$

Therefore an economic policy that limits dispersion in economic aggregates promotes economic welfare. In other words a well designed policy keeps price dispersion in the economy small. Limited price dispersion translates into a smoothed consumption plan of households.

The relative weight the social planer puts on stabilising prices l_p versus stabilising wage inflation l_w depends on the relative stickiness in these markets. If labour markets are more inertial than good markets they are the main source of welfare losses. Accordingly stabilisation policy should foster wage stability more than price stability. If only prices are sticky and labour markets are flexible, only inflation matters $(l_p = 0)$, if on the other hand only wages are sticky and prices are flexible than only wage dispersion matters $(l_w = 0)$. Output stabilisation as an independent goal of monetary policy, only plays a minor role for the conduct of monetary policy. This result can be rationalised by the existence of a flat Phillips curve. If monetary policy is coined towards inflation targeting the output gap will necessarily exhibit a larger degree of dispersion in the vague of cost push shocks as it is used by the planer to stabilise inflation. Additionally we assume that interest rate smoothing as well as smoothing the fiscal instrument are prime motives of the social planer. Instrument smoothing can be rationalised by a broad range of arguments. Among them are for instance that the ECB does not want to disrupt financial markets. Additionally gradualism can be a direct result of uncertainties to which a monetary policy maker is exposed (Brainard uncertainty, model uncertainty, data uncertainty ((Martin and Salmon Chris 1999))). From a theoretic perspective instrument smoothing is a device of making use of private sector expectations of further interest rate steps in the same direction in a forward looking environment (Lansing and Bharat 2001)). Empirical estimates for $l_{\Delta i}$ range from 0.1 in microfounded analysis as presented by Woddford (2003) up to 12.3 as estimated by Dennis (2003). In our analysis we put a weight of $l_{\Delta i} = 0.5$ on interest rate smoothing. As a first shot guess and in the absence of a reference value we will assume that fiscal policy puts a weight of $l_{\Delta g} = 0.25$ on smoothing the fiscal stance parameter.

3 Analysis of Equilibrium Dynamics

We now combine the described first order conditions to analyse the equilibrium dynamics in state space notation. After some substitutions we can rewrite the equilibrium dynamics as follows.

$$\begin{bmatrix} x_{1,t+1} \\ E_t x_{2t+1} \end{bmatrix} = A \begin{bmatrix} x_{1,t} \\ x_{2,t} \end{bmatrix} + BI_t + n_{t+1} \tag{3.1}$$

$$x_{1,t} = \{ l_t^a \quad l_t^g \quad l_t^p \quad l_t^w \quad \Delta p_{t-1} \quad y_{t-1} \quad x_{t-1} \quad \Delta w_{t-1} \quad g_{t-1} \quad r_{t-1} \quad l^a_{-i,t} \quad l^g_{-i,t} \quad l^p_{-i,t} \quad l^w_{-i,t} \quad \Delta p_{-i,t-1} \quad y_{-i,t-1} \quad x_{-i,t-1} \quad \Delta w_{-i,t-1} \quad g_{-i,t-1} \}$$
$$x_{2,t} = \{ y_t \quad \Delta w_t \quad \Delta p_t \quad y_{-i,t} \quad \Delta w_{-i,t} \quad \Delta p_{-i,t} \}$$

For a detailed description of the derivation and necessary substitutions see Appendix 1. We assume the social planer has the following target vector

$$z_t = \{ p_t \quad \Delta w_t \quad y_t \quad \Delta i_t \quad \Delta g_t \},$$

which can be equivalently expressed with the help of a measurement equation as follows

$$z_t = C_x x_t + C_I I_t, \tag{3.2}$$

so that the period loss function can be stated as:

$$
\begin{aligned}
L_t &= z_t^{'} K z_t \\
&= \begin{bmatrix} x_t^{'} & I_t^{'} \end{bmatrix} \begin{bmatrix} C_x^{'} \\ C_I^{'} \end{bmatrix} K \begin{bmatrix} C_x & C_I \end{bmatrix} \begin{bmatrix} x_t \\ I_t \end{bmatrix} \\
&= x_t^{'} C_x^{'} K C_x x_t + x_t^{'} C_x^{'} K C_i I_t + I_t^{'} C_i^{'} K C_x x_t + i_t^{'} C_i^{'} K C_i I_t \\
&= x_t^{'} Q x_t + x_t^{'} U I_t + I_t^{'} U^{'} x_t + I_t^{'} R I_t
\end{aligned} \tag{3.3}
$$

where it holds that:

$$
\begin{aligned}
Q &= C_x^{'} K C_x \\
U &= C_x^{'} K C_i \\
R &= C_i^{'} K C_i
\end{aligned}
\quad
K = \begin{bmatrix} l_p & 0 & 0 & 0 & 0 \\ 0 & l_w & 0 & 0 & 0 \\ 0 & 0 & l_y & 0 & 0 \\ 0 & 0 & 0 & l_i & 0 \\ 0 & 0 & 0 & 0 & l_g \end{bmatrix} \tag{3.4}
$$

The optimal set of policy rules under discretion is given by:

$$I_t = F x_{1,t} \tag{3.5}$$

where:

$$I_t = \begin{bmatrix} i_t & g_t \end{bmatrix} \tag{3.6}$$

The linear feedback rules can be stated as follows:

$$\begin{bmatrix} i_t \\ g_t \end{bmatrix} = \begin{bmatrix} f_{i,1} & \cdots & f_{i,19} \\ f_{g,1} & \cdots & f_{g,19} \end{bmatrix} x_{1,t} \tag{3.7}$$

where e.g. $f_{i,3}$ denotes the reaction coefficient of the interest rate with respect to the third predetermined variable (a cost push shock) and $f_{g,5}$ denotes the response of the fiscal stance with respect to the fifth predetermined variable (the lagged inflation rate). As shown in Bofinger and Mayer (2005) the optimal instrument mix between the fiscal and the monetary instrument depends on the ratio of the absolute size of the impact multiplier of fiscal policy in relation to the impact of the real interest rate on the optimal consumption schemes of households. When the impact of the fiscal stance parameter on economic activity increases the social planer gradually shifts the preferred mix towards the fiscal instrument. The logic is quite simple. As the use of instruments is penalised quadratically a higher impact multiplier gives an improved leverage on aggregate demand schemes with less cost. As Gali and Perotti (2003) found evidence that the fiscal policy stance in the post-Maastricht era is mildly anticyclical we fix the fiscal impact multiplier at $o = 0.1$. Accordingly in our baseline scenario we assume that fiscal policy is only cautiously present at the euro-area level. In the next section we fit the model to the data by assuming that the ECB conducts its policy according to the notion of inflation targeting and that fiscal policy is only used cautiously in line with the evidence reported by Gali and Perotti (2004).

In section 5 we will introduce a benevolent European government that forms a great coalition with the ECB to minimise a joint loss function. Thereby we analyse the hypothetical welfare gain of moving towards a more active stance in fiscal policy. For this counterfactual experiment we fix the fiscal multiplier in accordance with related studies at $o = 0.75$ (see Bartolomeo Giovanni Di, Engwerda Jacob, Plasmans Joseph, Aarle, Bas van and Tomasz Michalalk (2005)).

3.1 Minimum Distance Estimation

The closed loop dynamics of the model which serves as a starting point to generate the sample autocorrelation functions (SACF) are given by:

$$x_{1,t} = \left(A_{11} + A_{12} C\right) x_{1,t} + u_{1,t+1} \tag{3.1.1}$$

$$x_{2,t} = C x_{1,t} \tag{3.1.2}$$

where A_{11} and A_{12} are the respective sub-matrices of $A = A_0^{-1} A_1$, which have been partitioned conformably with $x_{1,t}$ and $x_{2,t}$. Using the algorithms as described in Söderlind (1999), the matrix C which maps the predetermined into the non-predetermined variables is determined numerically. For matching the unconditional sample autocorrelation functions, we estimate the following set of parameters,

$$z = \left(q_p^{i} \quad q_p^{-i} \quad q_w^{i} \quad q_w^{-i} \quad w_i \quad w_{-i} \quad a_i \quad a_{-i} \quad h_i \quad h_{-i} \quad i \quad g\right)$$

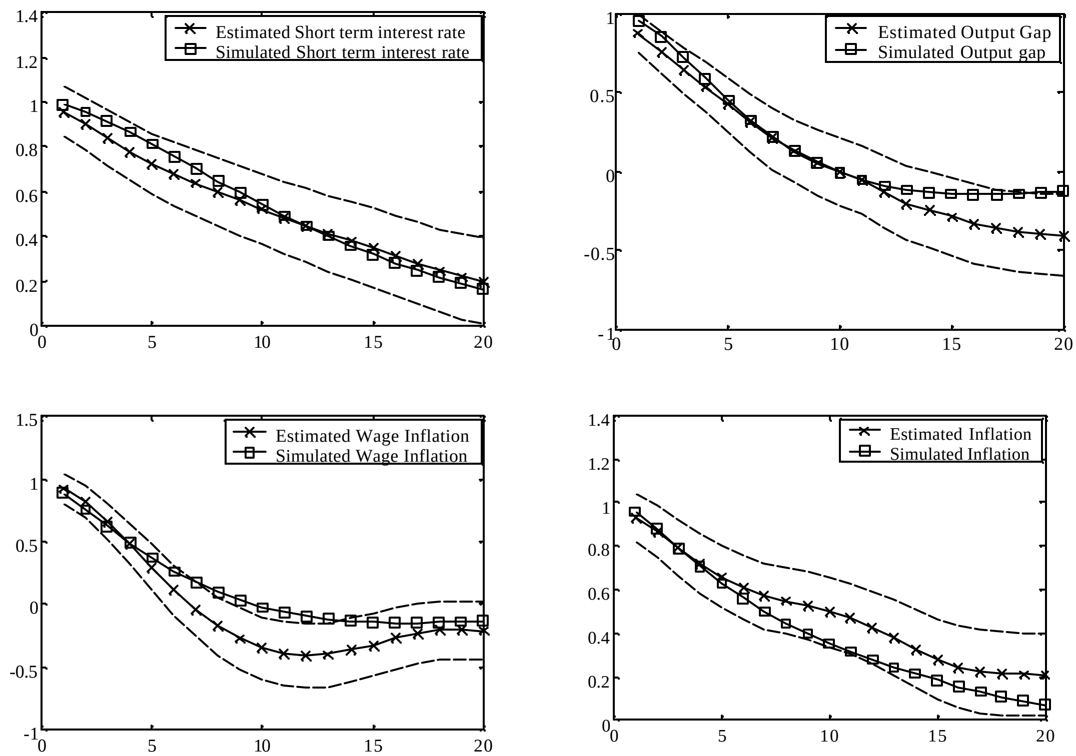
by minimising an Euclidean norm between the theoretical sample autocorrelations and the empirical sample autocorrelations for the most recent quarterly euro-area data (1983-2003). The remaining parameters were calibrated as proposed by Smets and Wouters (2004) (see Appendix 2). The optimal estimator V minimises the corresponding distance measure of $J^{opt}\left(V\right)$ (see e.g. Christiano, Eichenbaum and Evans (2004)).

$$J = \min_{V} \left(\hat{\Psi} - \Psi\left(V\right)\right)' V^{-1} \left(\hat{\Psi} - \Psi\left(V\right)\right) \tag{3.1.3}$$

where $\hat{\Psi}$ denote the empirical sample autocorrelations, $\Psi\left(V\right)$ describe the mapping from V to the theoretical sample autocorrelations and V is the weighting matrix which we have set equal to the identity matrix.

Figure 5 and Table 1 presents the estimates. The estimates are broadly in line with those documentedby other small scale models of the business cycle as reported in Smets and Wouters (SW) (2004), Rabanal and Ramirez (2003) or Christiano, Eichenbaum and Evans (CEE).

Figure 5: Minimum distance estimation by matching theoretical to the empirical SACF



The dotted lines plot the approximate two standard error bounds at the five percent significance level.

In these related studies the degree of Calvo-pricing ranges from 0.5 (CEE) to 0.9 (SW). The estimates for the degree of price indexation w range from 0.3 (SW) up to 1 (CEE). The degree of indexation in labour markets α is estimated between 0.92 (SW) and 1 (CEE). For the degree of habit formation values between 0.6 up to 0.7 can be found. Note that the weight the ECB attaches to stabilise wage inflation was estimated somewhat higher than the weight attached towards stabilising prices, although the weights are very comparable in size as l_p was set equal to 0.5.

Concerning the degree of asymmetry the two blocs of the monetary union to which we have assigned a GDP weight of 75% and 25% respectively do not diverge systematically in the degree of stickyness in labour and good markets. Nevertheless the small bloc exhibits less habit persistence in consumption decisions.

Table 1 Parameter estimates

PARAMETER	SYMBOL	ESTIMATE
Large Bloc		
Calvo prices	q_p^i	0.8659
Calvo wages	q_w^i	0.6849
Degree of price indexation	w_1^i	0.5303
Degree of wage indexation	a_i	0.9070
Habit formation	h_i	0.7747
Small Bloc		
Calvo prices	q_p^{-i}	0.7792
Calvo wages	q_w^{-i}	0.6873
Degree of price indexation	w_1^{-i}	0.3378
Degree of wage indexation	a_{-i}	0.9112
Habit formation	h_{-i}	0.700
Common Parameters		
Weight on wage stabilization	l_w	0.5424
TOT effect in IS-equation	i	-0.0556
Labour supply Elasticity	g	1.0835

4 Macroeconomic Dispersion in the Euro-Area and the Implied Economic Mechanisms

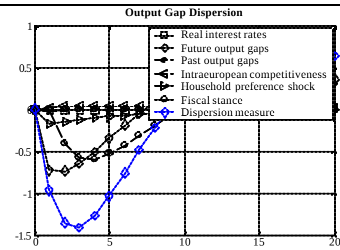
Given the rich set of underlying deep parameters of New Keynesian macro-models this section aims at identifying those parameters that make the difference. Hence we want to identify those underlying parameters that are most causal for the observed persistence in macroeconomic outcomes across the currency area. Therefore we take a look at symmetric and asymmetric shocks originating from the demand and supply sides. We show this by performing an exemplary experiment of shocks originating in the small bloc of the monetary union. It prevails that these have the potential to drive macroeconomic aggregates persistently apart. The persistence is partly driven by asymmetries and partly by the dispersion itself. We construct measures that decompose the overall dispersion in output gaps and inflation rates into its sub-components. Each indicator will be decomposed into a component that can be assigned to structural asymmetries and one component that is driven by the dispersion.

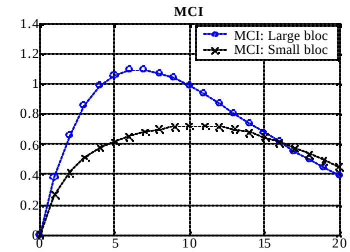
For the case of asymmetric shocks that originate from the small bloc of the monetary union the following results stand out: The high degree of persistence in mean dispersion is mainly driven by three factors. Firstly, by the highly autocorrelated shock sequences itself. Following Smets and Wouters (2004) we have calibrated the autocorrelation coefficients of a shock to households preferences at $r_g = 0.83$. This high degree of inertia and rational agents knowledge on the injection of sustained shocks fosters highly persistent deviations in macroeconomic aggregates. Secondly, the hybrid structure of the model which includes habits in consumption and indexation on parts of price and wage setters creates a persistent environment in itself. Thirdly, and most importantly the figure indicates that the ECB is helpless against asymmetric shocks as it responds with a policy that fits on average. Nevertheless stabilising the aggregates on average necessarily creates some further dispersion in the convergence process towards the inflation target. This diagnose is clearly confirmed by analysing the MCI's. The small bloc that experiences the increase in consumption has looser monetary conditions than the rest of the union. This effect of asymmetric shocks is easily understood as the ECB can only set its interest rate at a level that fits on average. Quite arguably this level will be too high for the countries that did not experience the boom in consumer spending and too low for the minor bloc of the currency area itself. In sum Figure 6 shows that a positive shock to households preferences induces households to consume more in the minor part whereas the rest of the union which has a GDP mass of 75% suffers from restrictive monetary conditions. Therefore the overall dispersion $\left(y_{i,t} - y_{-i,t}\right)$ following a positive shock to households preferences is negative. From an economic perspective we have two causal mechanisms simultaneously at work. On the one hand diverging real interest rates which potentially disrupt the monetary union as households will use different reallocation schemes for their optimal consumption decisions depending on their intertemporal elasticities of substitution. On the other hand the effect of intra-european competitiveness as expressed in terms of trade effects which is always stabilizing in itself. Making use of the constructed dispersion indicators (see Appendix 3)

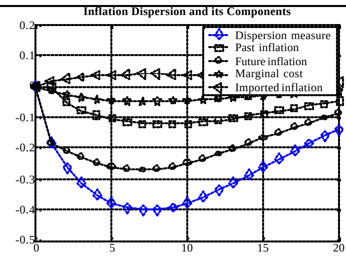
$$\left(y_{i,t} - y_{-i,t}\right) = \sum_{i=1}^{5} I_i^y \tag{4.1}$$

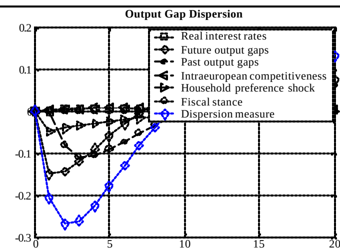
Figure 6 (a) shows that the main source of dispersion is largely driven by expected future deviations of output and inflation differentials itself that feeds back on the current values of these aggregates in a forward-looking environment. The economic mechanisms, hence the divergence in real interest rates and the divergence in intra-European competitiveness, although causal for the amplitudes in expectational variables, only play a minor role in terms of absolute size.

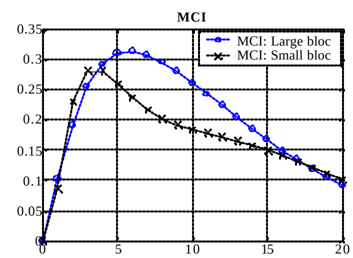
Figure 6: Evolution of output dispersion measures in response to a shock to households preferences

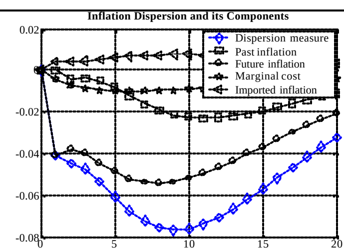
<table>
<tr><th>HOUSEHOLD PREFERENCE SHOCK</th><th>DISPERSION</th><th>MONETARY CONDITION INDEX</th></tr>
<tr><td rowspan="2">Asymmetric</td><td>


(a)</td><td rowspan="2">


(c)</td></tr>
<tr><td>


(b)</td></tr>
<tr><td rowspan="2">Symmetric</td><td>


(d)</td><td rowspan="2">


(f)</td></tr>
<tr><td>


(e)</td></tr>
</table>

The impact of symmetric shocks is less pronounced as the ECB can adequately set its instrument in such a way that fits almost optimally. The figure shows that the monetary conditions across the currency area as expressed in terms of MCI's only diverge marginally. The observed discrepancy between the MCI's can be traced back to the asymmetric structure of the economies.

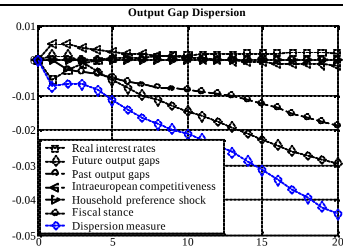
These results carry over to supply shocks originating from price mark-ups. In the case of an asymmetric supply shock emanating from the small bloc of the currency area monetary conditions largely diverge across the area. A supply shock in the small but not negligible part of the currency area gives a push to the inflation rate π_i that lowers its own real interest rate. This calls the ECB upon to act only insofar as the average European inflation rate increases. Therefore the initial expansionary impact is not totally undone by subsequent raising real interest rates. The rest of the union will suffer under the contractionary monetary conditions. Decomposing the overall effect into its sub-components by the proposed indicators (see Appendix 3)

$$\left(p_{i,t} - p_{-i,t}\right) = \sum_{i=1}^{4} I_i^p \ , \tag{4.2}$$

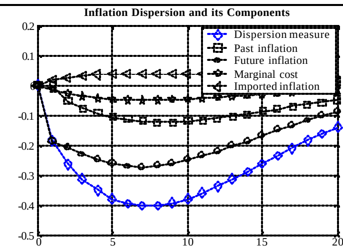
we see that the hybrid structure of the Phillips curve contributes for the major part of mean dispersion. The difference in transmission structures only plays a meaningful role in the case of symmetric shocks.

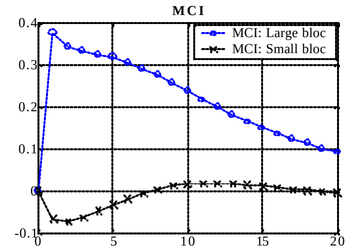
Reviewing the insights gained we conclude that the biggest threat to a monetary union is the occurrence of asymmetric shocks originating from a minor but not negligible part of the currency area. Therefore we will evaluate the impact of fiscal policy in the next section under varying assumptions on the variance-covariance matrix. Additionally we find evidence for self-sustaining dispersion due to the lead lag structure enshrined in the hybrid New Keynesian equations. Therefore we opt to analyse the beneficial impact of fiscal policy under varies assumptions on the degree of stickiness in intermediate good markets and over varies degrees of habit formation.

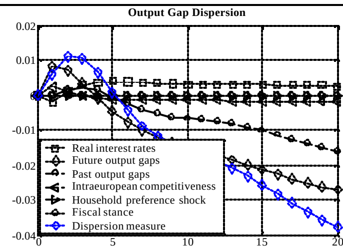
Figure 7: Evolution of output and inflation dispersion measures in response to a shock to price mark-ups

<table>
<tr><th>PRICE MARK-UP SHOCK</th><th>DISPERSION MEASURE</th><th>MONETARY CONDITIONS INDEX</th></tr>
<tr><td>Asymmetric</td><td>


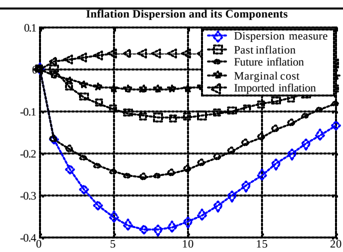
(a)

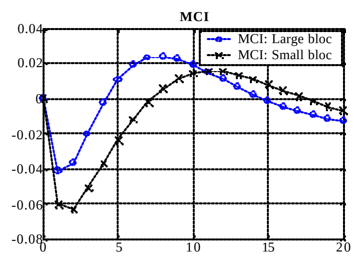


(b)
</td><td>


(c)
</td></tr>
<tr><td>Symmetric</td><td>


(d)



(e)
</td><td>


(f)
</td></tr>
</table>

5. Assessing the Impact of Fiscal Policy

Section 4 has examined the main forces that are causal for driving persistent wedges between macroeconomic aggregates by means of symmetric and asymmetric impulse response functions and derived indicators. Our results suggest that the degree of price stickiness in the Philips curves and the degree of habit formation in the intertemporal Euler equations are of utmost importance in explaining persistent wedges.

To evaluate the overall welfare impact of fiscal policy we have to specify a variance-covariance matrix Σ_{vv} depicting our belief on the degree of correlation between the structural shocks of the individual member countries. The absolute values of standard deviations are set equal to the estimates of Smets and Wouters (2004) (see Appendix 2). There is quite some discussion whether the very introduction of a currency area has altered the correlation structure of shocks. Karman and Weimann (2003) find evidence from bivariate VAR-analysis that demand and supply side shocks of the European economies have converged to a degree of correlation of 0.5. In an earlier study Angeloni and Dedola (1999) present estimates for the correlation of structural shocks of round about 0.2. Bruneau and de Bondt (1999) found modest negative correlation of -0.11 in fiscal spending shocks prior to the introduction of the monetary union. The correlation of fiscal spending shocks is set equal to null in our baseline scenario. Based on these values we propose the following variance-covariance matrix, where we assume that the correlation in structural shocks is 0.5. As robustness check we will equally compute the welfare measure under the assumption that the correlation is equal to 0.2.

$$\Sigma_w = \left[\begin{array}{ccccccccccccccccccc}
0.46 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.23 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & 0.03 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.016 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & 0.04 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.022 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & 0.08 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0.39 & 0 & 0 & 0 & 0 & 0 \\
 & & & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & 0.17 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & 0.01 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & 0.37 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & 0.03 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & & 0.04 & 0 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & & & 0.06 & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & & & & 0 & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & & & & & 0 & 0 & 0 & 0 \\
 & & & & & & & & & & & & & & & & 0 & 0 & 0 \\
 & & & & & & & & & & & & & & & & & 0 & 0 \\
 & & & & & & & & & & & & & & & & & & 0.17
\end{array}\right]$$

Note that from the perspective of the ECB it would be favorable if the correlation of structural shocks is one. This would imply that asymmetric shocks could be ruled out. We measure the percentage reduction in loss due to the second instrument as follows. Throughout the analysis we keep the loss function fixed at:

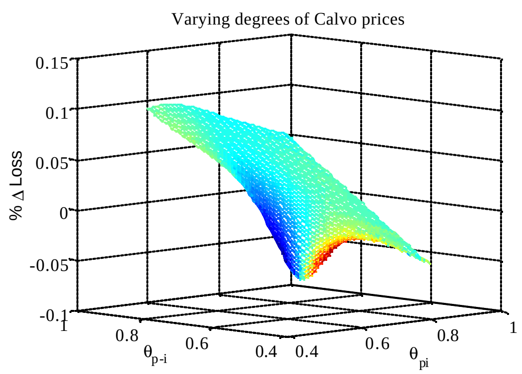
$$L_t = 0.5p_t^2 + 0.556\Delta w_t^2 + 0.05y_t^2 + 0.5\Delta i_t^2 + 0.25\Delta g_t^2 \tag{5.1}$$

For this period loss function we compute the implied loss for two scenarios. Under scenario A fiscal policy remains passive. Under scenario B fiscal policy actively engages in fighting economic cycles. We mimic these two alternative scenarios by varying the fiscal impact multiplier from $o = 0.1$ to $o = 0.75$.

We compare these two fiscal stances by the following measures that compute the percentage loss reduction that can be attached to fiscal policy (see Svensson and Rudebusch, 1999, p. 240).

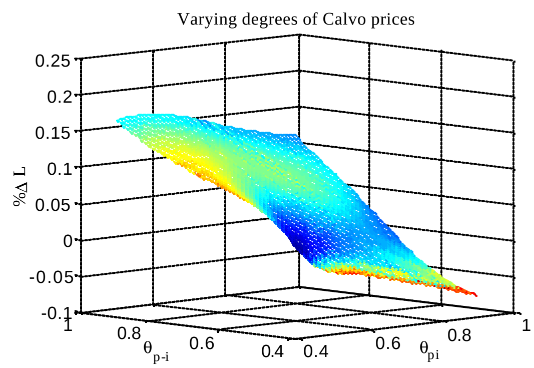
$$\%\Delta L = \frac{\left. x_{1,0}V' x_{1,0} + \frac{b}{1-b} trace\left(V'\Sigma_w\right)\right|_{o=0.1} - \left. x_{1,0}V' x_{1,0} + \frac{b}{1-b} trace\left(V'\Sigma_w\right)\right|_{o=0.75}}{\left. x_{1,0}V' x_{1,0} + \frac{b}{1-b} trace\left(V'\Sigma_w\right)\right|_{o=0.75}} \tag{5.2}$$

Figure 8: The Percentage loss reduction due to fiscal policy



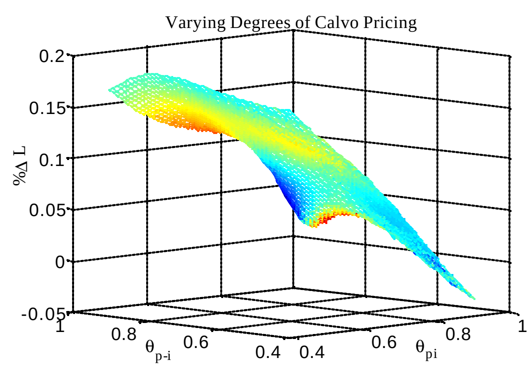
(A)

BASELINE CALIBRATION



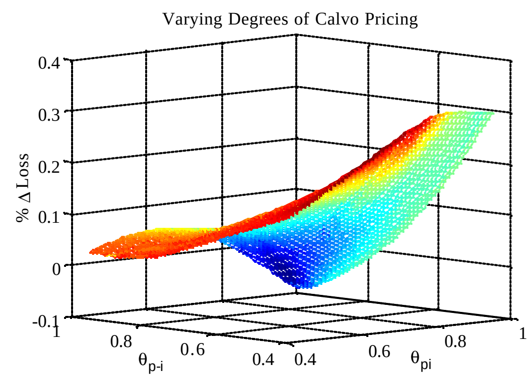
(B)

HIGHER INTEREST RATE SMOOTHING



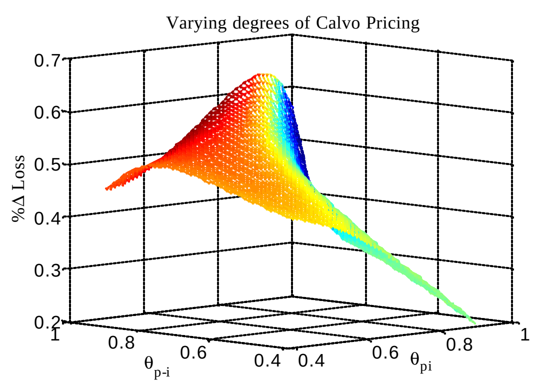
(C)

LOWER COVARIANCES IN SHOCKS



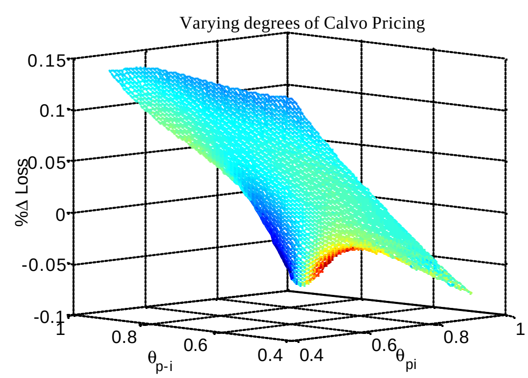
(D)

HIGHER DEGREE OF HABIT FORMATION



(E)

HIGH DEMAND SHOCKS



(F)

HIGH SUPPLY SHOCKS

Analyzing the percentage loss reduction $\%\Delta L$ the following results stand out. For the baseline scenario (see Figure 8 (a)) we find evidence that fiscal policy will ceteris paribus be more efficient if intermediate good markets become more sticky. Hence the more price setters are unable to adjust prices to a changing economic environment the stronger the need for a second stabilization agent that induces those price setters that can freely adjust prices to set them exactly in the neighborhood of those prices that are fixed. Secondly, it prevails in the baseline scenario that a second instrument gets in particular welfare enhancing if the small bloc of the currency area exhibits a high degree of stickiness whereas the rest of the union is characterized by a low degree of stickiness. Obviously under such a setting the implied structural asymmetries across the currency area are at its maximum. These results qualitatively carry over to all variations of the baseline scenario. But let us discuss the results in turn.

If we deviate from the baseline by assuming that monetary policy is conducted more gradual by moving in terms of $l_{\Delta i}$ from $l_{\Delta i} = 0.5$ to $l_{\Delta i} = 1$ the loss reduction associated to fiscal policy increases. Remember that estimates of $l_{\Delta i}$ range up to 12.3 (Dennis (2003)). This clearly indicates that fiscal policy is more necessary in an environment when monetary policy is implemented gradually as a second instrument could respond more strongly on impact.

In Figure 8(c) we have altered the variance-covariance matrix and in particular the degree of correlation of structural shocks hitting the demand side (household preferences) and supply side (price mark-up, wage mark-up, production function) of the economy. As alternative specification we have considered the estimates as reported in Angeloni and Dedola (1999). In economic terms this means that the environment for monetary policy becomes less favorable as the probability that the currency area will be hit by an asymmetric shock increases. Not surprisingly a lower covariance of shocks creates an environment where fiscal policy becomes more welfare enhancing. Accordingly we can report evidence that fiscal policy becomes more important ceteris paribus if the currency area is subject to asymmetric shocks.

Figure 8 (d) indicates that stronger habit formation in both parts of the monetary union increases the likelihood that fiscal policy has a positive impact on economic welfare. If consumption decisions by households are more strongly driven by past behavior the introduction of a second instrument can induce households faster to reverse their consumption plans towards the long run equilibrium. Fiscal policy becomes ceteris paribus more effective if the asymmetries between the member states increase.

Figure 8(e) and (f) report the results from changing the variances of the supply or demand shocks by a factor of ten. Obviously the analysis indicates that fiscal policy implemented via the demand side of the economy shows its merits in particular if the economy is hit by large demand disturbances, whereas increasing the turbulence in the supply side of the economy only has a modest impact on the measure $\%\Delta L$.

In sum we conclude that fiscal policy has the potential to reduce the loss imposed on society in particular under scenarios which are of a particular concern for currency areas. Among them are the nature of correlation between structural shocks hitting the individual countries as well as the degree of asymmetries of the member states.

5 Conclusions

Five years after the launch of third stage EMU the conversion in central macroeconomic aggregates has come to an halt. Related studies have indicated that this development might be either rooted in different degrees of inflation persistence or in different impacts of real exchange rates on the individual member countries (see Angeloni, Egrmann (2004); Honohan, Lane (2003)). Additionally the vulnerability of a currency area to asymmetric shocks is well known. Within this paper we have estimated an asymmetric euro-area model with sticky prices and sticky wages and compared it to other small scale models of the transmission mechanism (e.g., Smets, Wouters (2003)). Our focus was set on exploring those forces that have the potential to let a currency area drift apart. We showed that the worst case scenario in terms of mean dispersion is triggered by asymmetric shocks originating from minor but not negligible parts of the currency area. As the common central bank is indifferent against mean preserving spreads persistent swings in central macroeconomic aggregates are induced. This results in highly mismatched MCI conditions for individual countries.

By decomposing the overall dispersion in means we saw that under persistent symmetric as well as under persistent asymmetric shocks the dispersion was driven by forces that could be attributed to the underlying structures of the two economies (e.g, inflation persistence and habit formation). In particular differences in the degree of price stickiness and habit formation are of utmost importance as they generate self-sustaining dispersion up to a certain time horizon as some economic agents simply index prices and wages or.

In the final section we implemented optimal control by two instruments and explored its merits in terms of loss reduction. We saw that under a broad set of alternative assumptions of the baseline scenario fiscal policy can have a beneficial impact on welfare in particular under scenarios which are under concern for currency areas. We find evidence that this conclusion holds in an environment with inertial intermediate good markets and high degrees of habit formation. Fiscal policy shows its merits if the union is subject to large shocks emanating from the demand side of the economy. Additionally fiscal policy becomes more important in an environment when the correlation of structural shocks decreases. We conclude that a monetary union calls for a renaissance of fiscal policy from a stabilisation perspective..

Appendix 1

Following Rabanal and Rubio Ramirez (2003) and he small scale model of the business cycle is described by the following set of equations. Note that we have only stated the equations for bloc i which counts for a GDP mass of 75%.

Production function

$$y_{i,t} = a_{i,t} + (1-d)\, n_{i,t}$$

Marginal cost:

$$mc_{i,t} = w_{i,t} - p_{i\,t} + n_{i,t} - y_{i,t}$$

Marginal rate of substitution

$$mrs_{i,t} = g_{i,t} + \frac{1}{((1-h)/(1+h)s_{c})} y_{i,t} + g\, n_{i,t}$$

Identity to close the model

$$x_{i,t} = x_{i,t-1} + \Delta w_{i,t} - \Delta p_{i,t}$$

Productivity Shocks

$$a_{i,t} = r_a a_{i,t-1} + e^{a}_{i,t}$$

Household preference shock

$$g_{i,t} = r_g g_{i,t-1} + e^{g}_{i,t}$$

Cost push shock

$$ms_{i,t} = r_{ms} ms_{i,t-1} + e^{ms}_{i,t}$$

Wage mark up shock

$$l_{i,t} = r_l\, l_{i,t-1} + e^{l}_{i,t}$$

Income Identity

$$y_{i,t} = c_{i,t} + g_{i,t}$$

To reduce the state space we make the following substitutions::

IS-curve:

Making use of the (12) rewrite the Euler equation as follows:

$$\frac{1}{1+h} y_{i,t+1} = y_{i,t} - \frac{h_i}{1+h_i} y_{i,t-1} + \frac{1-h_i}{(1+h_i) s_c}\left(r_{i,t} - \Delta p_{i,t+1}\right) - s\, g_{i,t} - \frac{1-h_i}{(1+h_i) s_c}\left(g^b_{i,t} - g^b_{i,t+1}\right) - i \Delta q_i$$

Hybrid Phillips curve:

$$g_{i,f} E_t \Delta p_{i,t+1} = \Delta p_{i,t} - g_{i,b} E_t \Delta p_{i,t-1} - k^{'}_{i,p}\left(mc_{i,t} + l_{i,t}\right)$$

To reduce the state space we have substituted in equation (11) marginal costs, the production function and the definition of the real wage we.

$$g_{i,f} E_t \Delta p_{i,t} = \Delta p_{i,t} - g_{i,b} \Delta p_{i,t-1} - k^{'}_{i,p} x_{i,t} - k^{'}_{i,p}\left[y_{i,t}\left((1-d)^{-1} - 1\right)\right] + k^{'}_{i,p}(1-d)^{-1} a_{i,t} - k^{'}_{i,p} l_{i,t} - e \Delta p_{-i,t}$$

Hybrid Wage dynamics:

$$b E_t \Delta w_{i,t+1} = \Delta w_{i,t} - a_i \Delta p_{i,t-1} + a_i b \Delta p_{i,t} - k_{i,w}\left(mrs_{i,t} - x_{i,t}\right)$$

To reduce the state space we have substituted in equation (12) the real wage, the production function and the marginal rate of substitution.

$$\begin{aligned} b E_t \Delta w_{i,t+1} &= \left(1 + k_{i,w}\right)\Delta w_{i,t} - a_i \Delta p_{i,t-1} + \left(a_i b - k_{i,w}\right)\Delta p_{i,t} \\ &- k_{i,w} x_{i,t-1} - k_{i,w} g_{i,t} - y_{i,t} k_{i,w}\left[\left(\tfrac{1}{(1-h_i)/(1++h_i)s_c}\right) + g\,(1-d)^{-1}\right] - k_{i,w} g\,(1-d)^{-1} a_{i,t} \end{aligned}$$

The individual matrices in state space notation are defined as follows:

$$
\begin{bmatrix}
1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{1+h_i} & 0 & \frac{1-h_i}{(1+h_i)s_c} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & g_{i,f} & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & \frac{1}{1+h_{-i}} & 0 & \frac{1-h_{-i}}{(1+h_{-i})s_c} \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & b & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & g_{i,f}
\end{bmatrix}
$$

$$
\begin{bmatrix}
r_a & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & r_g & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & r_l & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & r_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & r_a & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & r_g & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & r_l & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & r_w & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & -1 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\
0 & -\frac{1-h_i}{(1+h_i)s_c} & 0 & 0 & 0 & -\frac{1-h_i}{(1+h_i)} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 1 & 0 & -i & 0 & 0 & i \\
k_{i,w}g(1-d)^{-1} & -k_{i,w} & 0 & -k_{i,w} & -a_i & 0 & -k_{i,w} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\left[k_{i,w}\left(\frac{1}{s}\right)+k_{i,w}g(1-d)^{-1}\right] & (1+k_{i,w}) & (a_i b-k_{i,w}) & 0 & 0 & 0 \\
k'_{i,p}(1-d)^{-1} & 0 & -k'_{i,p} & 0 & -g_{ib} & 0 & -k'_{i,p} & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -k'_{i,p}\left((1-d)^{-1}-1\right) & -k'_{i,p} & (1+k'_{i,p}) & 0 & 0 & e \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & -\frac{1-h_{-i}}{(1+h_{-i})s_c} & 0 & 0 & 0 & -\frac{1-h_{-i}}{(1+h_{-i})} & 0 & 0 & 0 & 0 & 0 & i & 1 & 0 & -i \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & k_{-i,w}g(1-d)^{-1} & -k_{-i,w} & 0 & -k_{-i,w} & -a & 0 & 0 & -k_w & 0 & 0 & 0 & 0 & -\left[k_{-iw}\left(\frac{1}{s}\right)+k_{-i,w}g(1-d)^{-1}\right] & (1+k_{-i,w}) & (a_{-i}b-k_{-i,w}) \\
0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & k'_{-i,p}(1-d)^{-1} & 0 & -k'_{-i,p} & 0 & -g_b & 0 & 0 & -k'_p & 0 & 0 & 0 & e & -k'_{-i,p}\left((1-d)^{-1}-1\right) & -k'_{-i,p} & (1+k'_{-i,p})
\end{bmatrix}
$$

$$x_{1,t}=\left\{ l_t^a \quad l_t^g \quad l_t^p \quad l_t^w \quad \Delta p_{t-1} \quad y_{t-1} \quad x_{t-1} \quad \Delta w_{t-1} \quad g_{t-1} \quad r_{t-1} \quad l_{-i,t}^a \quad l_{-i,t}^g \quad l_{-i,t}^p \quad l_{-i,t}^w \quad \Delta p_{-i,t-1} \quad y_{-i,t-1} \quad x_{-i,t-1} \quad \Delta w_{-i,t-1} \quad g_{-i,t-1} \right\}$$

$$x_{2,t}=\left\{ y_t \quad \Delta w_t \quad \Delta p_t \quad y_{-i,t} \quad \Delta w_{-i,t} \quad \Delta p_{-i,t} \right\}$$

$$\begin{bmatrix} 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 1 \\ 1 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ 0 & 0 \\ \frac{(1-h_i)}{\left[(1+h_i)s_c\right]} & -o \\ 0 & 0 \\ 0 & 0 \\ \frac{(1-h_{-i})}{\left[(1+h_{-i})s_c\right]} & -o \\ 0 & 0 \\ 0 & 0 \end{bmatrix}$$

Appendix 2

Parameter calibration taken from Smets Wouters (2004)

PARAMETER	VALUE
f : elasticity of substitution between different kinds of labour	6
$\bar{e}$: mean of the price mark-up	6
d : capital share	0.3
b : Discount factor	0.99
r_a : persistence in technology shocks	0.94
r_g : persistence in household preference shocks	0.84
r_l : persistence in supply shocks	0.93
r_m : persistence in monetary shocks	0.93
s_a% : standard deviation of technology shocks	0.61
s_g% : standard deviation of household preference shocks	0.32
s_l% : standard deviation of mark-up shock	0.19
s_g% : standard deviation of monetary shock	0.11
$s_f^{\%}$: standard deviation of fiscal shock	0.37

Baseline Calibration forthe loss function

WEIGHTS	l_p	l_w	l_y	$l_{\Delta i}$	$l_{\Delta g}$
LOSS	0.5	0.5424	0.05	0.5	0.25

Appendix 3

Given equation (A.10) we can decompose the temporary mean dispersion from steady state follows

$$\left(y_{i,t} - y_{-i,t}\right) = \sum\nolimits_{i=1}^{5} I_i^y$$

Indicator I_1^y : Divergence in the shock sequence

$$\begin{aligned} I_5^y &= \frac{1-h_i}{(1-h_i)} e_{i,t}^b - \frac{1-h_{-i}}{(1-h_{-i})} e_{-i,t}^b \\ &= \left(\frac{1-h_i}{(1-h_i)} - \frac{1-h_{-i}}{(1-h_{-i})} \right) e_{-i,t}^b + \frac{1-h_i}{(1-h_i)} \left(e_{i,t}^b - e_{-i,t}^b \right) \end{aligned}$$

Indicator I_2^y : Diverging real interest rates

$$\begin{aligned} I_1^y &= \left(\frac{1-h_{-i}}{(1-h_{-i}) s_c} \right) \left[i_t - \Delta p_{i,t+1} \right] - \left(\frac{1-h_{-i}}{(1-h_{-i}) s_c} \right) \left[i_t - \Delta p_{-i,t+1} \right] \\ &= \left[\left(\frac{1-h_{-i}}{(1-h_{-i}) s_c} - \frac{1-h_i}{(1-h_i) s_c} \right) \right] i_t + \left[\left(\frac{1-h_i}{(1-h_i) s_c} - \frac{1-h_{-i}}{(1-h_{-i}) s_c} \right) \right] \Delta p_{-i,t+1} + \frac{1-h_i}{(1-h_i) s_c} \left(\Delta p_{i,t+1} - \Delta p_{-i,t+1} \right) \end{aligned}$$

Indicator I_3^y : Divergence in expected output gaps

$$\begin{aligned} I_2^y &= \frac{1}{1+h_i} y_{i,t+1} - \frac{1}{1+h_{-i}} y_{-i,t+1} \\ &= \left(\frac{1}{1+h_i} - \frac{1}{1+h_{-i}} \right) y_{-i,t+1} + \frac{1}{1+h_i} \left(y_{i,t+1} - y_{-i,t+1} \right) \end{aligned}$$

Indicator I_4^y : Divergence in past output gaps

$$\begin{aligned} I_3^y &= \frac{h_i}{(1+h_i) s_c} y_{i,t-1} - \frac{h_{-i}}{(1+h_{-i}) s_c} y_{-i,t-1} \\ &= \left(\frac{h_i}{(1+h_i) s_c} - \frac{h_{-i}}{(1+h_{-i}) s_c} \right) y_{-i,t-1} + \frac{h_i}{1+h_i} \left(y_{i,t-1} - y_{-i,t-1} \right) \end{aligned}$$

Indicator I_5^y : Divergence in Terms of Trade Effects

$$I_4^y = 2iq_i$$

Given equaion (A.11) we can decompose the mean dispersion ininflation as follows:

$$I_4^p = e\left(p_{-i,t} - p_{i,t}\right)$$

Indicator I_2^p : Divergence in past inflation rates

$$
\begin{aligned}
I_1^p &= g_{i,b}\Delta p_{i,t-1} - g_{-i,b}\Delta p_{-i,t-1} \\
&= \left(g_{i,b} - g_{-i,b}\right)\Delta p_{-i,t-1} + g_b\left(\Delta p_{i,t-1} - \Delta p_{-i,t-1}\right)
\end{aligned}
$$

<u>Indicator I_3^p :</u> Divergence in Expected Inflation

$$
\begin{aligned}
I_2^p &= g_{i,f}\,\Delta p_{t+1} - g_{-i,f}\,\Delta p_{-i,t+1} \\
&= \left(g_{i,f} - g_{-i,f}\right)\Delta p_{t+1} + g_{i,f}\left(\Delta p_{i,t+1} - \Delta p_{-i,t+1}\right)
\end{aligned}
$$

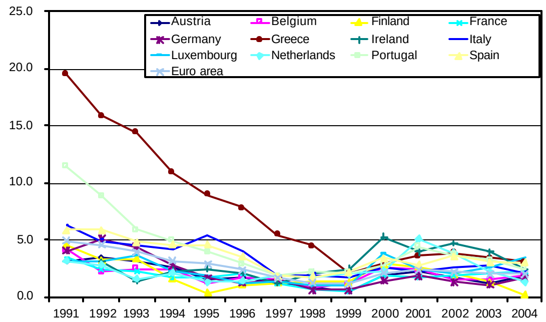
<u>Indicator I_4^p :</u> Divergence in marginal Costs

$$
\begin{aligned}
I_3^p &= k'_{i,p} mc_{i,t} - k'_{-i,p} mc_{-i,t} \\
&= \left(k'_{i,p} - k'_{-i,p}\right) mc_{i,t} + k'_{i,p}\left(mc_{i,t} - mc_{-i,t}\right)
\end{aligned}
$$

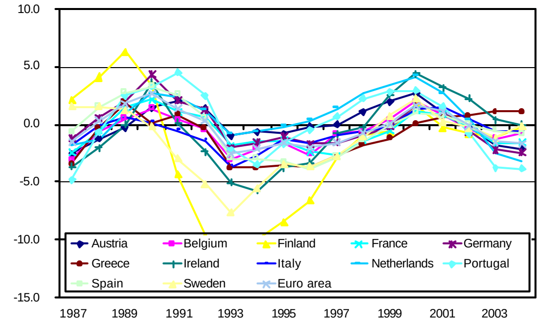
Appendix 4

Data

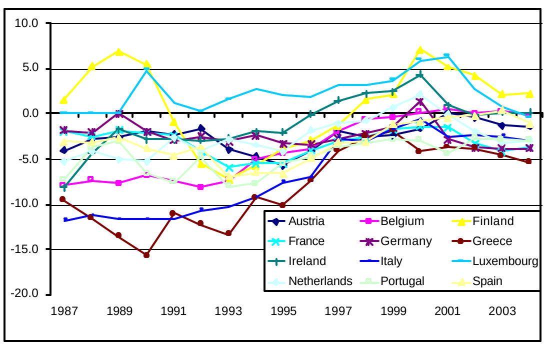
INFLATION



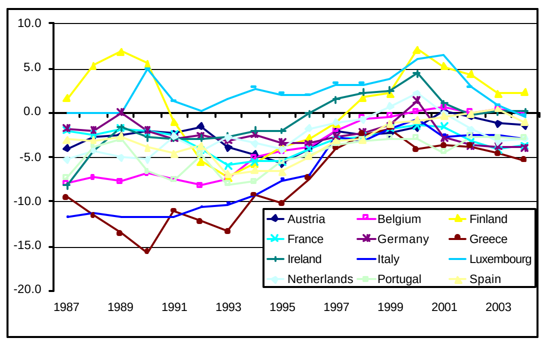
OUTPUT GAPS



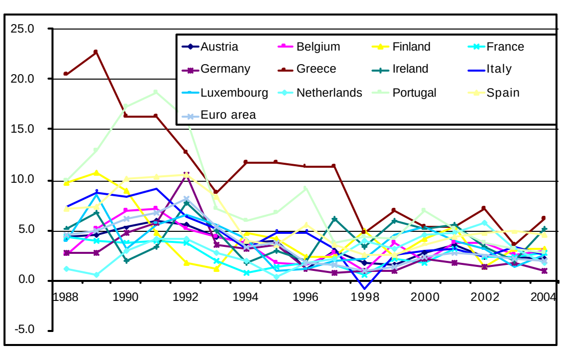
CYCLICALLY ADJUSTED BALANCE



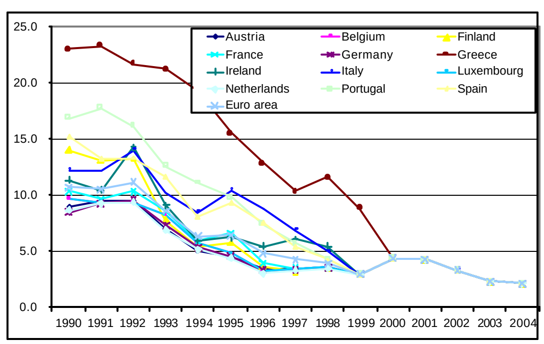
FINANCIAL BALANCES



COMPENSATION PER EMPLOYEE



SHORT TERM RATES



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