EUROPEAN CENTRAL BANK

QUANTIFYING THE IMPACT OF STRUCTURAL REFORMS

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1. Introduction[1]

Structural reforms have been stressed recurrently by the ECB as being of particular importance for the euro area. In particular, important positive effects on productivity, output and employment growth have been seen as resulting from more flexible labour and product markets that would free up resources, strengthen incentives for innovative and productive activities and allow for a more rapid adjustment to structural shocks. Some if not all of these effects have been the object of a rapidly increasing literature regarding the long-term impact of structural reforms.

However, while the long-run consequences of structural reforms have received increasing attention in the literature, including a discussion regarding political economy problems related to an optimal implementation of reforms, the influences of structural reforms on short- to medium-term dynamics have rarely been examined[2]. This, however, seems to be an important *lacuna* in the literature on structural reforms for at least two reasons:

- On the one hand, researchers increasingly acknowledge the interaction between shocks at business cycle frequency and the long-term trend of output and employment growth (Long and Plosser, 1983). In particular, several authors have recently claimed that distorted relative prices due to structural rigidities may cause shocks having lasting (negative) effects on long-term performance, either because of asymmetric reactions of the economy to shocks (Caballero and Hammour, 1998) or due to the role of structural rigidities in resolving microeconomic incentive problems in the presence of temporary shocks (Ramey and Watson, 1997).
- On the other hand, a more rapid adjustment of an economy to a temporary shock is thought to help reducing the welfare costs of business cycle fluctuations while at the same time allowing for a more rapid transmission of monetary and fiscal policies. Similarly, a speedier reaction following a permanent shock has the potential to reduce inflationary pressures when bringing the economy more rapidly to the new steady state. Both aspects of increased market flexibility have been recently analysed as raising the "resilience" of an economy to shocks

While questions related to the first issue are of genuine interest for a central bank when determining the reaction to an exogenous shock or the conduct of monetary policy, addressing the second issue can add to our understanding of the medium-run effects of the monetary policy transmission mechanisms. From the

[1] This work has benefited from extensive and helpful interactions with M. Lenza (EMO) as well as from comments made during an ECB-internal presentation.

[2] For an important (recent) exception see Bayoumi, Laxton and Pesenti (2004); OECD (2003); Derose, Langedijk and Roeger (2004).

point of view of the ECB, at least, it seems that the relative scarcity of evidence on the effect of structural reforms in these two areas is a clear *lacuna* that deserves to be filled.

In general, nominal rigidities on product and labour markets tend to reduce the speed of adjustment of prices and wages following both a demand and a supply shock. Real variables, however, are likely to react more strongly – in particular in reaction to a demand shock – in case of high nominal rigidities. In addition, in models that account for sectoral differences, nominal rigidities entail distortions in the allocation of resources across sectors under the impact of any type of shock, leading to efficiency losses. Finally, under the impression of real rigidities on the labour market, output fluctuations will be further increased whereas the pressure on price and wage adjustment increases. Table 1 and Table 2 summarise the different possibilities that are discussed in more details in the following.

Table 1: Output and price fluctuations in the presence of demand shocks

		Output fluctuations		**Price fluctuations**	
		Nominal rigidity		Nominal rigidity	
		High	*Low*	*High*	*Low*
Real rigidities on labour markets	*High*	+	–	–	+
	Low	++	0	– –	0

Note: The table indicates the (relative) speed of adjustment of output and prices following a shock (either negative or positive) on the aggregate demand curve in the presence of nominal rigidities (on both labour and product markets) and real labour market rigidities (in the form of employment adjustment costs). For each type of indicator (output fluctuations and price fluctuations) a reference value has been defined (indicated by "0") that represents the benchmark of a completely flexible economy. The size of all other adjustments have been determined in reference to that value: "–" weaker, "+" stronger, "++" much stronger adjustments.

Source: OECD, 2003; ECB

Table 2: Reaction speed of output and prices following a supply shock

		Output fluctuations		Price fluctuations	
		Nominal rigidity		Nominal rigidity	
		High	*Low*	*High*	*Low*
Real rigidities on labour markets	*High*	–	– –	– –	–
	Low	+	0	–	0

Note: The table indicates the (relative) speed of adjustment of output and prices following a shock (either negative or positive) on the aggregate supply curve in the presence of nominal rigidities (on both labour and product markets) and employment adjustment costs. For each type of indicator (output fluctuations and price fluctuations) a reference value has been defined (indicated by "0"). The size of all other fluctuations have been determined in reference to that value: "–" weaker, "+" stronger, "++" much stronger fluctuations.

Source: OECD, 2003; ECB

1.1.1 Reducing nominal price and wage persistence

As can be seen from the right panels of the above tables, nominal rigidities on product and labour markets induce prices and wages to react slowly to a shock on either the aggregate demand (see Table 1) or the aggregate supply curve (see Table 2). While nominal rigidities buffer prices and wages against quick reactions to shocks (right panel of the two tables), quantities – in particular output – are likely to react more strongly than in the case of flexible markets, in particular to a demand shock (left panel of the two tables).

Structural reforms that aim at reducing rigid prices or nominal wages will therefore increase the reactivity of prices/wages under either type of shock. On the other hand, the extent to which output has to react following a supply or demand shock is reduced when prices and wages are more flexible: the transition to the new steady state (in case of a supply shock) or the return to the long-run (vertical) supply curve is quicker in case of flexible markets.

Examples of structural policies that help to reduce price rigidities include the reduction of the number of price controls or the existence of administrative prices, i.e. the size of the public sector. Moreover, structural reforms aiming at a reduction of market entry barriers such as red tape, a more efficient tax system or a reduction of market power for insiders (such as reforms of employment protection legislation or the administrative extension of wage bargaining contracts) can equally help to reduce nominal rigidities on both labour and product markets.

1.1.2 Facilitating employment adjustment

Opposite to nominal rigidities, constraints on real variables to adjust to aggregate supply or demand shocks will induce changes in the reaction of nominal prices and wages. Moreover, the impact of both output and

price fluctuations in the presence of real rigidities depends on the nature of the shock. It should be noted that real (labour market) rigidities refer in this context to employment adjustment costs only.

In the presence of a demand shock, real (labour market) rigidities will put stronger pressure on prices to adjust (the short-run Phillips curve becomes steeper) as firms will be less inclined to hire new workers (in case of a positive shock) or will have difficulties to reduce their existing workforce (in case of a negative shock) to cope with changes in demand. Consequently, the adjustment of output may depend on whether nominal rigidities are high (strong pressure on output to adjust) or low (low output adjustment).

In the presence of a supply shock, real rigidities in form of employment adjustment costs prevent the economy to move rapidly to the new steady state. Hence, the flexible economy will move more rapidly to the new equilibrium, adjusting prices and output more speedily. Moreover, the profile of the price adjustment process follows that of the output adjustment: the higher the reactivity of output the stronger prices will fluctuate.

Finally, reducing real rigidities such as quantitative adjustment costs for employment will reduce steady state inflation through its impact on insider bargaining power: with firms having difficulties to fire workers, those currently employed may be able to adjust their wages to any nominal shock, putting pressure in turn on producer prices to increase. To the extent that firms have pricing powers in their respective market (for instance due to market entry barriers or capital adjustment costs), these wage increases will be passed on to the consumer.

Available evidence on the costs of rigidities that an economy bears in the presence of supply or demand shocks indicate that both real and nominal rigidities are expected to have large losses in terms of swings in unemployment and the time it takes for an economy to return to equilibrium. The OECD, for instance, estimates that following a temporary demand shock of 2% of the baseline output, the economy may take 2-3 times longer to return to equilibrium in the presence of price and wage rigidities[3]. Moreover, cumulative unemployment may rise to 150% of the level in the flexible case and may take up to 4 years longer to return to its steady state level.

2. Model set-up and estimation

In order to assess the importance of structural rigidities such as those discussed in the preceding section and their importance for European economies, we will make use of a Real Business Cycle model with price rigidities and disequilibrium on the labour market. The main deviation from the standard perfect competition model underlying the usual RBC model is here that transactions can take place off the

[3] OECD (2003), "Structural flexibility and the resilience of economies to shocks", ECO/CPE/WP1(2003)7

equilibrium path. This in turn opens the possibility for real aggregate demand to affect actual production, the return on investment and hence the evolution of the capital stock.

In the following, we will describe the main lines of the model. Thereafter, we will describe the methods that have been applied to estimate the structural parameters of the model. In a second section, we will more closely describe our measure of the degree of labour market disequilibrium across countries. Finally, we will match this measure with indicators that have been established earlier to distinguish clearly between real and nominal rigidities in our model.

2.1 The Disequilibrium model[4]

The underlying macroeconomic model follows closely established standards in the literature. In particular, it is based on a dynamic general equilibrium model with a representative household that determines its consumption and leisure pattern with respect to a budget constraint and an accumulating capital stock. The economy is subject to a continuous stream of technology shocks, which are supposed to be the only source of disruption. Two model variants will be analysed, one being the standard, perfect competition case, the other one the case where labour market transactions can take place off the equilibrium path. Finally, as money is not included in this model, prices will be absent and wages representing real wage developments

2.1.1 The model

The economy is characterised by a representative household and a representative firm. Agents enter market exchanges in three markets: the product, the labour and the capital market. The household owns all factors of production and sells factor services to the firm and buys its products for consumption or accumulation of the capital stock. The product market is assumed to be imperfectly competitive, with the firm facing a perceived demand curve and a sticky price (fixed at $p=1$).

Unlike the standard RBC model with competitive markets, the market in this model will be re-opened at the beginning of each period t, necessary to ensure adjustment in response to a non-clearing labour market. The non-clearing of the market is caused by wage stickiness as the sequence of wages $\{w_t\}_{t=0}^{\infty}$ is contracted and preset at $t=0$ and will not be allowed to change even if the market does not clear. The decision process, therefore, has two stages: in a first step, households determine their consumption and labour supply pattern, in a second step, they re-optimise their consumption plans following the realised transactions on the factor market.

[4] This section resumes the paper by Gong and Semmler (2003).

At period *t*, the representative household expects a series of technology shocks $\{E_t A_{t+i}\}_{i=0}^{\infty}$ and real wages and interest rates $\{E_t w_{t+i}, E_t r_{t+i}\}_{i=0}^{\infty}$. The decision problem of the household is then to choose a sequence of planned consumption and labour effort $\{c_{t+i}^d, n_{t+i}^s\}_{i=0}^{\infty}$ such that

$$\max_{\{c_{t+i}^d, n_{t+i}^s\}_{i=0}^{\infty}} E_t\left[\sum_{i=0}^{\infty} \beta^i U\left(c_{t+i}^d, n_{t+i}^s\right)\right] \tag{A1.1}$$

subject to

$$\begin{aligned} c_{t+i}^d + i_{t+i}^d &= r_{t+i} k_{t+i}^s + w_{t+i} n_{t+i}^s + \pi_{t+i} \\ k_{t+i+1}^s &= \frac{1}{1+\gamma}\left[(1-\delta)k_{t+i}^s + f\left(k_{t+i}^s, n_{t+i}^s, A_{t+i}\right) - c_{t+i}^d\right] \end{aligned}$$

where subscripts *d* and *s* stand for "demand" and "supply", β designates the intertemporal preference rate, δ the depreciation rate, π firms' profits and γ stands for the stationarity parameter. Using standard dynamic programming techniques, this optimal planning problem can be solved to yield the solution sequence $\{c_{t+i}^d, n_{t+i}^s\}_{i=0}^{\infty}$; however, from each sequence only the first tupel $\left(c_t^d, n_t^s\right)$ is actually carried out.

In the first period *t*, the firm decides upon its inputs $\left(k_t^d, n_t^d\right)$ given expected demand for its products Ey_t related to its perceived demand curve. Standard (one-period) profit maximization yields the factor demand functions:

$$\begin{aligned} k_t^d &= f_k\left(r_t, w_t, A_t, Ey_t\right) \\ n_t^d &= f_n\left(r_t, w_t, A_t, Ey_t\right) \end{aligned} \tag{A1.2}$$

As the capital market is supposed to be perfectly competitive, the rental rate of capital, r_t, adjusts in each period such as to clear the market: $k_t = k_t^s = k_t^d$. On the labour market, however, the fixed wage contract does usually not allow to clear the market[5].

In order to assess the impact of structural rigidities on labour markets, we introduce nominal wage rigidity in the first period, such that actual employment does no longer correspond to labour supply for that period. In order to determine actual transactions on the labour market, a transaction rule has to be defined. In the standard disequilibrium literature on which the approach of this note is built, the short side of the market is supposed to determine the outcome, formalised by the minimization rule:

$$n_t = \min\left(n_t^d, n_t^s\right).$$

However, such an assumption may be too restrictive an assumption as employment may need time to adjust from one period to the other. Here, instead, we want to modify this rule to allow labour transactions

[5] This may nevertheless happen if either the representative firm has perfect foresight on the sequence of technology shocks or the wage contract is settled in the form of a contingency plan. Both will be excluded here; see Gong and Semmler (2003, p. 7) on a discussion on this latter point.

off the labour demand schedule. This may happen, for instance, when employment is negotiated or when firms hoard labour in downturns, employing more than the profit-maximising level of workers. The rule that we want to use here can be described as:

$$n_t = \omega n_t^d + (1-\omega) n_t^s,$$

where ω measures the degree to which employment is determined by labour demand and will play a key role in the interpretation of the model and its results.

Once the factor inputs have been determined, the firm proceeds with deciding its output level. Note that the firm is constrained not only by a potential disequilibrium on the labour market but also by the prospects of product market demand (recall that prices are fixed), Ey_t. Hence the firm will select the optimal capital stock[6] to optimise the following program:

$$\begin{aligned} \max_{k_t^d} \quad & y_t - r_t k_t^d - w_t n_t \\ s.t. \quad & y_t = f\left(A_t, k_t^d, n_t\right) \\ & y_t \le \hat{y}_t \end{aligned}$$

where $\hat{y}_t$ is the realisation of Ey_t in period t, yielding the output supply function $y_t^s = f\left(k_t, n_t, A_t\right)$.

Once output supply has been determined, the representative household needs to re-optimise given the difference between actual and planned employment levels. Given the realised factor transactions (k_t, n_t) implicitly given by the above output supply function equation, this new optimal planning program writes as:

$$\max_{c_t^d} E\left[U\left(c_t^d, n_t\right) + \sum_{i=1}^{\infty} \beta^i U\left(c_{t+i}^d, n_{t+i}^s\right) \right] \tag{A1.3}$$

subject to

$$\begin{aligned} k_{t+1}^s &= \frac{1}{1+\gamma}\left[(1-\delta)k_t^s + f\left(k_t, n_t, A_i\right) - c_t^d\right] \\ k_{t+i+1}^s &= \frac{1}{1+\gamma}\left[(1-\delta)k_{t+i}^s + f\left(k_{t+i}^s, n_{t+i}^s, A_{t+i}\right) - c_{t+i}^d\right], \quad i = 1,2,\ldots \end{aligned}$$

which can be used to derive the consumption demand based on realised transactions in the factor markets and the realisation of the technology shock in period *t*.

[6] Notice that capital markets clear instantaneously and capital can be adjusted at no cost following an unfavourable realisation of the demand shock.

2.1.2 Some specifications

In order to implement the model empirically (see the summary in the following box), certain specifications regarding the preference function, the technology shock and the stationarity of the time series have to be made.

The economy is represented by a consumer characterised by an instantaneous utility function over consumption, *c*, and leisure, *l=1-n*:

$$U(c,n) = \ln(c) + \theta \ln(1-n)$$

with θ the elasticity between consumption and leisure to be estimated with the data. Moreover, technological shocks are supposed to follow and AR(1) process:

$$A_{t+1} = a_0 + a_1 A_t + \varepsilon_t \text{ where } \varepsilon_t \sim N(0, \sigma_\varepsilon^2)$$

The stationarity parameter, γ, can be retrieved by calculating the trend growth rate of output. Finally, employment, n_t, is based on (normalised) hours worked (sample mean $\overline{N}$), considering that only 1/3 of a day is dedicated to work on average.

Box: The data generation process

The data generation process can be summarised as follows

- The evolution of the – stationnarised – capital stock

$$k_{t+1} = \frac{1}{1+\gamma}\left[(1-\delta)k_t + A_t k_t^{1-\alpha}\left(n_t \overline{N}/0.3\right)^{\alpha} - c_t\right]$$

- The technological evolution

$$A_{t+1} = a_0 + a_1 A_t + \varepsilon_t$$

- The production function

$$y_t = A_t k_t^{1-\alpha}\left(n_t \overline{N}/0.3\right)^{\alpha}$$

- Labour supply

$$n^s = G_{11} A_t + G_{12} k_t + g_1$$

- Labour demand

$$n_t^d = \begin{cases} \left(0.3/\overline{N}\right)\left(Ey_t / A_t\right)^{1/\alpha} k_t^{(\alpha-1)/\alpha} & \text{if} \quad Ey_t < \left(\alpha A_t Z_t / w_t\right)^{1/(1-\alpha)} k_t A_t \\ \left(\alpha A_t Z_t / w_t\right)^{1/(1-\alpha)} k_t \left(0.3/\overline{N}\right) & \text{if} \quad Ey_t \geq \left(\alpha A_t Z_t / w_t\right)^{1/(1-\alpha)} k_t A_t \end{cases}$$

- Actual employment

$$n_t = \omega n_t^d + (1-\omega) n_t^s$$

- Consumption decision

$$c_t = G_{21} A_t + G_{22} k_t + G_{23} n_t + g_2$$

- Expected production

$$Ey_t = y_{t-1}$$

2.2 Estimation of structural parameters

In order to estimate the model described in the previous section, several parameters have to be determined. These include: (i) the parameters describing the process of technological progress; (ii) the preference parameters and the depreciation rate of the capital stock and (iii) the labour market disequilibrium parameter.

While the first parameters can be estimated easily be estimating an AR(1) process using the TFP residuals that can be derived from a standard growth accounting exercise, the preference parameters are deeply linked to the first-order conditions that result from solving the above dynamic programming problem. This fact can be used to apply GMM techniques in order to estimate these parameters[7]. Concretely, the parameters are chosen such as to match the moments of the model described by the first-order conditions of the above model to those of the underlying data. Notice, moreover, that these parameters can be established without a concrete knowledge about the underlying labour market disequilibrium as they are supposed to be unrelated to it.

Given the highly non-linear nature of the optimisation problem, the algorithm used to pick the right parameters β, δ and θ had to ensure that any local optimum of the GMM technique is to be avoided. Here, a technique called simulated annealing has been applied, that combines a grid search procedure with an objective function – the temperature – to assess the size of the grid jumps. The resulting parameters for our 15 countries can be found in the following table. Note that the wage share, α, has not been estimated but taken from country tables, averaging the values over the corresponding periods for these countries[8].

[7] Instead of estimating the unknown parameters of a specific model, generalised method of moments (GMM) techniques require only a set of moments which the model should satisfy. GMM techniques are particularly useful if only consistent but not necessarily efficient parameter estimates are required and have been widely used in the estimation of dynamic general equilibrium models (see Mátyás, 1999, for a good introduction into these techniques).

[8] See section 6.1 for the different country-specific time periods.

Table 3: Structural parameters

Country	β	δ	θ	α
BE	0.9921	0.0075	2.7814	0.6432
DE	0.9999	0.0170	3.1536	0.6095
ES	0.9999	0.0273	3.0063	0.6301
FI	0.9646	0.0815	2.0212	0.6168
FR	0.9832	0.0174	2.7310	0.6320
IE	0.9953	0.0152	2.8683	0.5895
IT	0.9986	0.0115	3.2141	0.6506
NL	0.9925	0.0218	0.0218	0.6082
AT	0.9803	0.0074	2.5686	0.6163
UK	0.9895	0.0115	2.7983	0.6410
SE	0.9957	0.0143	3.1159	0.6135
NO	0.9999	0.0420	3.0661	0.5370
US	0.9999	0.0306	3.1714	0.6383
CA	0.9957	0.0210	2.9700	0.6105
JP	0.9904	0.0082	3.5475	0.6782

Note: The table reports the estimates of the structural parameters for the intertemporal time preference (β), the depreciation rate of capital (δ); the substitution elasticity between consumption and leisure (θ) and the substitution elasticity between capital and labour (α).

Source: Own calculations, OECD (2004)

While the time preference rates are relatively close across countries, corresponding to the standard interval for these models between 0.95 and 0.99, the country sample displays a large range of values for the capital depreciation rates, probably reflecting some country specific trends[9]. In particular the value for Finland seems to be excessively large, implying an annual depreciation rate of 36%; this may be related to the particular events surrounding the deep economic crisis in 1993. The other two parameters seem to form a reasonable range, although it must be conceded that no commonly accepted estimates exist regarding the substitution elasticity between consumption and leisure.

Given these structural parameters, we can now proceed with the estimation of the disequilibrium model by relaxing the assumption that labour markets always clear. If they do not, then our above transaction rule holds and to the extent to which labour demand rather than labour supply determines the final outcome will have some consequences for the dynamics of the whole macroeconomic system.

[9] Note that the depreciation rates correspond to quarterly values; the annual values can be derived by calculating $(1-\delta_i)^4$.

2.3 Estimations of labour market disequilibrium

Having determined the structural parameters relating to preferences, capital depreciation and the labour share, the model must now be estimated to establish the extent to which labour market disequilibrium is influenced by labour supply relative to labour demand. Being one of the main policy variables to be estimated in the model, care has to be taken regarding the interpretation of results, which will be undertaken in the following paragraph; first, we will describe the estimation procedure of the ω-parameter.

Once the first three parameters have been specified, the model can be calibrated using the realised technology shocks (instead of the simulated ones), which corresponds to the standard RBC presentation. In our case, however, the calibration serves a different purpose, namely to recover the theoretical labour demand and labour supply decisions of firms and households at each point in time. This, in turn, can be used to determine the ω-parameter simply by minimising the residual square sum of the difference between actually observed employment and model-generated employment. In formal terms:

$$\omega = \arg\min \sum_t \left[n_t - \left(\omega n_t^d + (1-\omega) n_t^s \right) \right]^2$$

The results of this estimation procedure and the resulting ω-parameters have been reported in Table 4 including both euro area and non-euro area OECD countries. For further reference, the table also reports values for institutional indicators regarding the tightness of employment protection legislation, the coordination of wage bargaining systems, union density and the tightness of product market regulation. All indicators have been taken from various OECD sources.

As can be seen from the table, the estimates for the ω-parameter of all euro area countries range at the lower end of the OECD sample with an (unweighted) average value of 18.7% and a standard deviation of 8.4% compared to 21.2% and 9.3% respectively for the whole sample and 25.0% and 9.9% for the non-euro area countries (Sweden, Norway, UK, US, Canada, Japan). Taking Ireland out of the euro area sample as a country coming close to the values of the UK and the US, the average estimates for the euro area would even be lower (16.9% and 7.0% respectively). Exactly how these estimations of the labour market adjustment process are affected by structural reforms is not immediately obvious from the model equations; in the next section we, therefore, turn to the question of relating existing indicators of structural rigidities to the estimates of the labour market disequilibrium process.

Table 4: Omega and institutions

Country	*Omega (ω)*	*Employment protection legislation*	*Wage bargaining coordination*	*Union density*	*Product market regulation*
BE	0,24	2,1	4,0	52,9	1,9
DE	0,26	2,8	4,0	29,0	1,4
ES	0,20	3,2	3,8	21,6	1,6
FR	0,10	3,1	2,0	9,0	2,1
IE	0,32	1,0	3,3	49,7	0,8
IT	0,13	3,3	2,8	24,1	2,3
NL	0,07	2,4	3,9	26,4	1,4
AT	0,22	2,4	4,4	42,0	1,4
FI	0,13	2,1	4,8	79,1	1,7
SE	0,21	2,4	3,4	91,0	1,4
UK	0,34	0,5	1,8	34,0	0,5
NO	0,19	2,9	4,3	58,0	2,2
US	0,40	0,2	1,0	14,9	1,0
CA	0,21	0,6	1,3	31,4	1,5
JP	0,14	2,6	4,0	24,0	1,5

Note: The table reports the estimates of the ω-parameter following the estimation procedure described in the text. In addition the table reports the OECD-indicators for the strictness of employment protection legislation, the level of wage bargaining coordination, the unionisation rates and the tightness of product market regulation.

The indicators for employment protection legislation and product market competition take values between 0 and 6, where 0 refers to least regulation and 6 to highest regulation. The indicator for wage bargainig coordination represents the average coordination level between 1975 and 2000 ranging from 1 for firm-level bargaining, 2 for fragmented industry and company-level bargaining, with little or no pattern-setting and 3 for industry-level bargaining with irregular pattern-setting and moderate co-ordination among major bargaining actors, 4 for (informal) co-ordinated bargaining by peak confederations, including government-sponsored negotiations (tripartite agreements, social pacts), or government imposition and 5 for (informal) co-ordination of industry-level bargaining by peak confederations.

Source: Own calculations, OECD (1998)

2.4 Interpreting Omega: Real or nominal rigidities?

The estimation of the model so far has provided for a first picture on the structural variety both within the euro area and among OECD countries. However, when trying to match the estimated parameters with particular reforms that would modify their values, the theoretical model gives only very scarce information. This is true, in particular, for the measure of the disequilibrium on the labour market, ω. While in the theoretical model, this statistic is identified by the extent to which employment is determined by labour demand, no clear indication is given as to which structural reform would affect this parameter and in which direction.

2.4.1 Comparing the ω-parameter with institutional indicators

In order to assess the influence of structural reforms on the ω-parameter, we analyse in this subsection in more detail exactly what type of reform would influence the labour market disequilibrium process. In particular, four hypotheses are analysed in more detail:

- Employment is determined by labour demand the stronger bargaining power of firms in the wage setting process is. In this case, the estimate would be inversely correlated with the unionisation rate of an economy;
- Similarly, the labour market disequilibrium process may be determined by nominal wage rigidities. While no immediate measure of nominal wage rigidity is available[10], a first proxy may be the level of coordination of wage bargaining systems: the higher the level of wage bargaining coordination, the more rigid nominal wages are across the economy;
- Labour supply may determine employment the higher quantitative labour adjustment costs are, such as strict employment protection legislation as labour demand has increasing difficulties to adjust;
- Finally, labour adjustment costs may also arise from market entry and exit as firm turnover is an important element in the determination of overall labour demand. Consequently, the estimate of ω may be correlated with product market regulation.

In order to assess which of these four elements best reflects our measure of the labour market disequilibrium process, four indicators have been taken from OECD studies that are widely used and cited in the literature. In particular, we have compared the cross-country variation of our ω-estimates with (i) the degree of wage bargaining coordination, (ii) the union density, (iii) the strictness of employment protection legislation and (iv) the degree of product market regulation (see Figure 1).

Following standard statistical significance measures, only the last two measures provide significant (negative) correlations with our estimated values of the ω-parameter, vindicating the interpretation of ω measuring quantitative adjustment costs on the labour market[11]. Wage bargaining coordination is only statistically significant at the 10% level, indicating that the ω-parameter may also represent nominal wage rigidities but to a lesser extent than real adjustment costs. However, the strong correlation of ω with both employment protection legislation and product market regulation does not allow any further differentiation between labour and product market (real) rigidities, which must be considered an important limitation that should be addressed in a follow-up to this work.

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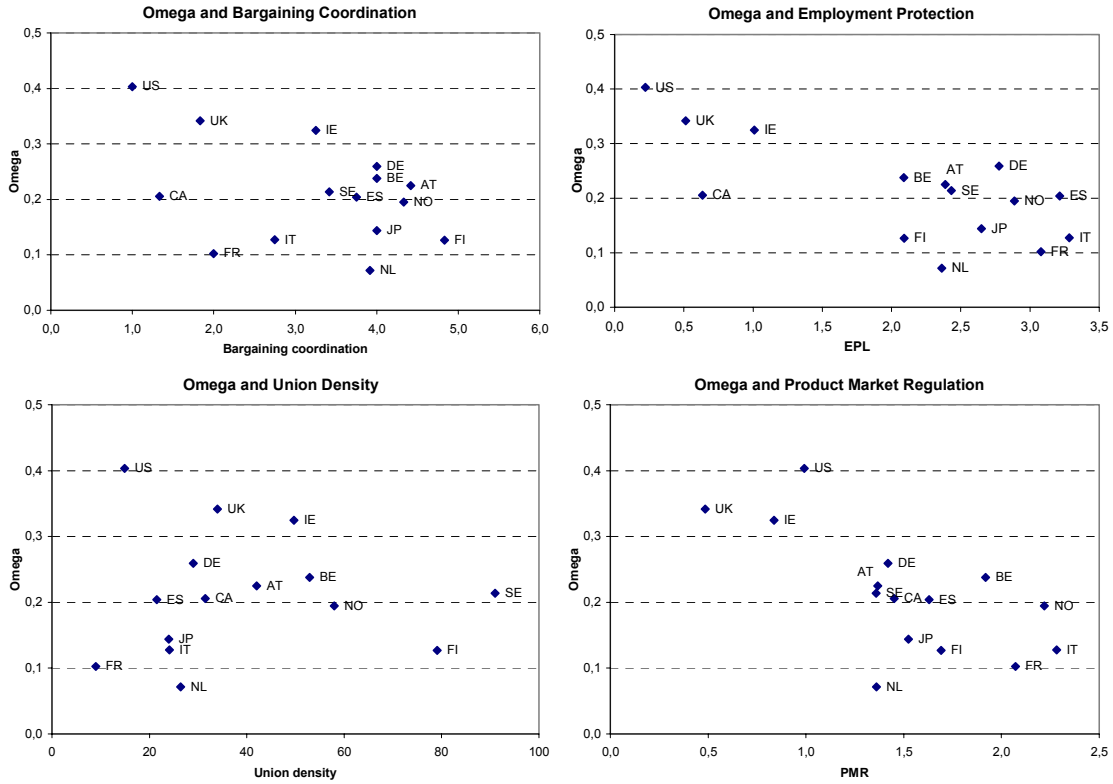
[10] See the International Wage Flexibility Network for a rare example of comparable nominal and real wage rigidity measures.

[11] Both employment protection and product market regulation may be related to quantitative adjustment process on the labour market: While employment protection refers to adjustment process related to firm-level employment turnover, product market regulation refers to adjustment process related to the turnover of firms in an industry.

Figure 1: Estimations of omega vs. institutional indicators



Note: The figures present plots of estimated omegas for OECD countries against different institutional indicators, such as the degree of wage bargaining coordination, the strictness of employment protection legislation, union density and the tightness of product market regulation.

Source: Own calculations, OECD (1998)

In order to facilitate the following discussion, we want to talk about a "flexible" economy when the ω-parameter is relatively high, approaching values for the UK, the US or Ireland, while we talk about "rigid" economies for values of the ω-parameter in the lower range. This may be warranted exclusively from the point of view of the correlation of ω with EPL and product market regulation and will help focusing the discussion in the following sections.

2.4.2 Some remarks on international differences of the ω-parameter

We have introduced rules that might be implemented when there is a non-clearing labour market. In this respect, as our calibration shows, the most promising route to model, and to match, stylized facts of the labour market, through a micro based labour market behaviour, is the compromising model. In principle, two characteristics of the labour market affect the magnitude of the ω in our compromising rule. The first is the (nominal) wage stickiness that drives a wedge between the household's desired supply of labour, n^s, as derived through optimal behaviour and the firm's optimal demand of labour, n^d. In the case of flexible wages, market clearing obtains at $n^s = n^d$. This is similar to Woodford's (2003, ch. 3) idea of a

deviation of the efficient and natural level of output where the efficient level of output is achieved only if there are no frictions in the economy. In our case, no frictions in the labour market cause n^s equals n^d.

On the other hand, there may be labour market institutions – such as corporatist structures – that directly impact on the employment level, either through efficient bargaining or employment adjustment costs; such institutions may also affect our measures of the ω-parameter. Recall, that our ω expresses how much weight is given to desired labour demand relative to desired labour supply. A small ω-parameter reflects the fact that the corresponding labour market institution has a high weight in determining the outcome of the employment compromise. Conversely, a high ω-parameter means that the firm is stronger in determining the employment outcome. As our empirical estimations have shown the former case, i.e. a low ω, is characteristic of Germany, France and Italy whereas a larger ω is found for the US and the UK.

Given the rather corporatist relationship of labour and the firm in some European countries, with some considerable labour market regulations through legislature and union bargaining (rules of employment protection, hiring and firing restrictions, extension of employment even if there is a shortfall of sales etc.)[12], our ω-parameter may thus measure differences concerning labour market institutions between the US and European countries. This has already been stated in the 1960s by Meyers:

> "One of the differences between the United States and Europe lies in our attitude toward layoffs... When business falls off, he [the typical American employer] soon begins to think of reduction in work force... In many other industrial countries, specific laws, collective agreements, or vigorous public opinion protect the workers against layoffs except under the most critical circumstances. Despite falling demand, the employer counts on retraining his permanent employees. He is obliged to find work for them to do... These arrangements are certainly effective in holding down unemployment". (Meyers, 1964).

Thus, we wish to argue that the major international difference causing employment variation does arise less from wage stickiness (due to the presence of unions and the extent and duration of contractual agreements between labour and the firm)[13] but rather seems to be related to real rigidities that impact on the speed of employment adjustment and the extent of labour hoarding in firms. Such a lower ω-parameter, which seems to be relevant for the compromising rule in euro area countries, can show up as difference in the variation of macroeconomic variables. This is demonstrated in Table 5 contrasting Germany with the US.

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[12] This could also be realised by firms by demanding the same (or less) hours per worker but employing more workers than being optimal. The case would then correspond to what is discussed in the literature as labour hoarding where firms hesitate to fire workers during a recession because it may be hard to find new workers in the next upswing, see Burnside, Eichenbaum and Rebelo (1993). Note that in this case firms may be off their marginal product curve and thus this might require wage subsidies for firms as has been suggested by Phelps (1997).

[13] In fact real wage rigidities in the U.S. are almost the same as in European countries, see Flaschel, Gong and Semmler (2001).

Table 5: Standard deviations (Germany vs. US)

	Germany	US
Consumption	0.0146	0.0084
Capital stock	0.0203	0.0036
Employment	0.0100	0.0166
Output	0.0258	0.0164
Temporary shock	0.0230	0.0115
Efficiency wage	0.0129	0.0273

Note: The table represents the standard deviations of the HP-filtered time series for Germany and the US over the period 1955Q1-1983Q1 (US) and 1960Q1-1992Q1 (Germany).

Source: Own calculations

In this comparison, employment and the efficiency wage (defined as real wage divided by productivity) are among the variables with the highest volatility in the US economy, while they are the smoothest variables in Germany. Second, in the US economy, the capital stock and temporary technological shocks are both relatively smooth. In contrast, they are both more volatile in Germany. These results are likely to be related to our first remark regarding the difference in employment volatility. The volatility of output must be absorbed by some factors in the production function. If employment is smooth, the other two factors have to be volatile.

Indeed, recent Phillips curve studies do not seem to reveal an important difference in wage stickiness between Germany and the US, although the German labour market is often considered to be less flexible[14]. Yet, there are differences in another sense: In Germany, there are stronger influences of labour unions and various legal restrictions on firms' hiring and firing decisions, a shorter work week at the same pay etc.[15] Such influences and legal restriction will give rise to the smoother employment series in contrast to the US and may be viewed as a readiness to compromise as our model suggests. Those factors will indeed give rise to a lower ω-parameter and a smoother employment series[16].

So far we only have shown that our model of non-clearing labour market seems to match better the variation in employment than the standard RBC model. Yet, we did not attempt to explain the secular trend of the unemployment rate neither for the US nor for Germany. However, trends in the unemployment rate may be particularly relevant for the time series in Table 5, which refer to a period where the US had higher – but falling – unemployment rates, whereas Germany had still lower but rising unemployment rates. Yet,

[14] See Flaschel, Gong and Semmler (2001).

[15] See, for example, Nickell (1997) and – for an early example – Meyers (1964).

[16] It might reasonably be argued that, due to intertemporal optimisation subject to the budget constraints, the supply specified by the decision rule may only approximate the decisions of those households for which unemployment is not expected to pose a problem on their budgets. Such households are more likely to be currently employed and protected by labour unions and legal restrictions. In other words, currently employed labour decides, through the optimal decision rule, about labour supply and not those who are currently unemployed. Such a feature could be studied by an intertemporal model with heterogeneous households.

since the end of the 1980s the level of the unemployment rate in Germany has considerably moved up, partly, of course due to the unification of Germany in 1990.In the following, we therefore present some elements of how our model can be used to study the trend shift in employment.

One recent attempt to better fit the RBC model's predictions with labour market data has employed search and matching theory[17]. Informational or institutional search frictions may then explain the equilibrium unemployment rate and its rise. Yet, those models usually observe that there has been a shift in matching functions due to evolution of unemployment rates such as, for example, experienced in Europe since the 1980s; the model itself, however, fails to explain such a shift[18].

In contrast to the literature on institutional frictions in the search and matching process we think that the essential impact on the trend in the rate of unemployment seems to stem from both changes of preferences of households as well as a changing trend in the technology shock[19]. Concerning the latter, as shown in Gong and Semmler (2003, ch. 9), the Solow residual, used in RBC models to account for the technology shock, heavily depends on endogenous variables such as capacity utilization, implying that exogenous technology shocks constitute only a small fraction of the Solow residual. We thus might conclude that cyclical fluctuations in output and employment are not likely to sufficiently be explained by productivity shocks alone. Gali (1999) and Francis and Ramey (2003) have argued that other shocks, for example demand shocks, are important as well.

In the long run, however, the change in the trend of the unemployment rate is likely to be related to the long-run trend in the true technology shock. Empirical evidence on the role of lagging implementation and diffusion of new technology for low employment growth in Germany can be found in Heckman (2003) and Greiner, Semmler and Gong (2004). This would have the effect that labour demand may fall short of labour supply, which is likely to occur in the long-run if productivity starts to grow at a lower rate which many researchers recently have maintained to have happened in Germany and other euro area countries over the 1990s.[20] It should be noted, however, that recent research has also stressed (see for example Phelps and Zoega (1997)), that there have been secular changes on the supply side of labour due to changes in preferences of households[21].

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[17] See Merz (1995) and Ljungqvist and Sargent (1998).

[18] For an evaluation of the search and matching theory as well as the role of shocks to explain the evolution of unemployment in Europe, see Blanchard and Wolfers (2000).

[19] See Campbell (1994) for a modelling of a trend in technology shocks.

[20] Of course, the trend in the wage rate is also important in the equation for labour demand (in equ. 25). For an account of the technology trend, see Flaschel, Gong and Semmler (2001), and for an additional account of the wage rate, see Heckman (2003). For a decomposition of the sectoral origins of the productivity slowdown in the euro area, see ECB (2004).

[21] Phelps and his co-authors have pointed out that an important change in the households' preferences in Europe is that households now rely more on assets instead of labour income.

3. Structural reforms and cyclical behaviour

3.1 Introduction

In addition to their impact on the long-run performance of the macro-economy, structural reforms are likely to affect also the short-run dynamics when making labour and product markets more flexible. This will have consequences for both the volatility of the variables following the impact of a shock and the correlation of macroeconomic variables. From the standpoint of macroeconomic (monetary) policy these issues are important to understand for at least two reasons: On the one hand, improved reaction to shocks allows for a more rapid return of the economy to the steady state. On the other hand, structural reforms may cause changes in the covariance of macroeconomic variables that allow for enhanced smoothing of income shocks across time, i.e. intertemporal smoothing[22]. In particular, less connected employment and consumption decisions improve the household's consumption smoothing, with potentially beneficial effects on the aggregate economy. In the following, these two issues are tackled by implementing changes in the value of the ω-parameter and the analysis of the ensuing standard deviations and correlations.

It has to be noted that the following analysis is concentrated on the volatility of a series, which is not equivalent to its reactivity or speed of adjustment in the presence of shocks but can only be regarded as a first approximation. Despite this limitation, however, some interesting new insights can be developed.

3.2 Labour market reforms in euro area countries

In the following, we will discuss country by country the impact that the policy experiments have on the short-term macroeconomic behaviour. It should be noted that for all policy experiments that are discussed in the following, the focus lies on the volatility of the main series and the correlations of these series with consumption and employment given that those with capital are rarely significant and should be taken as indicative only.

3.2.1 Spain

For Spain, an interesting situation arises as the increase in flexibility by moving gradually from an increase of the ω-parameter by one standard deviation (of the euro area sample) towards the US-level, the volatility of the main macroeconomic variables increases. This may be partly related to a decreasing connection between employment and consumption volatility, an interpretation, which is also warranted when comparing the Spanish case with Germany presenting similar characteristics. The fundamental reason may be the fact that a more flexible labour market allows for an improvement of the intertemporal smoothing:

[22] Intertemporal smoothing is concerned with hedging of non-diversifiable risk (Allen and Gale, 2000, ch. 6). While in the absence of more sophisticated financial contracts than exist in this model, such risk cannot be shared across different time periods, structural rigidities are likely to create endogenously fluctuations that make the reaction to an income shock more pronounced.

employment decisions are more likely to reflect the opportunity costs of leisure (i.e. wages), an element that has been stressed by the RBC literature.

Table 6: Policy experiments in Spain

Actual omega

Standard deviations

Consumption	0.006
Capital	0.003
Employment	0.005
Production	0.013

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.300	1.000		
Employment	0.828	0.061	1.000	
Production	0.965	0.074	0.909	1.000

Improvement by 1 std. deviation

Standard deviations

Consumption	0.005
Capital	0.003
Employment	0.005
Production	0.012

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.274	1.000		
Employment	0.703	0.153	1.000	
Production	0.964	0.075	0.808	1.000

Improvement to UK levels

Standard deviations

Consumption	0.005
Capital	0.003
Employment	0.005
Production	0.012

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.255	1.000		
Employment	0.594	0.212	1.000	
Production	0.962	0.075	0.725	1.000

Improvement to US levels

Standard deviations

Consumption	0.005
Capital	0.003
Employment	0.006
Production	0.012

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.224	1.000		
Employment	0.450	0.271	1.000	
Production	0.957	0.071	0.620	1.000

Note: The table shows the calibration results of 5000 simulations when implementing different values for the ω-parameter compared to the benchmark case when ω equals its actual value. Three different policy experiments have been run: ω=0.29, $\omega=\omega^{UK}$ and $\omega=\omega^{US}$. The table reports all standard deviations and correlations irrespective of the statistical significance.

Source: Own calculations

3.2.2 Germany

As mentioned already, Germany displays a similar behaviour to the Spanish case. In particular, there is an improvement – albeit a slight one – of volatility measures across the board for all three policy experiments compared to the benchmark case. Part of the reason for the lower impact of an improvement in the ω-parameter lies with the fact that the measured ω for Germany is already at the higher end of the euro area country sample (but still sufficiently far away from its value for the UK to warrant such a policy experiment). Moreover, a non-linear reaction of the employment-consumption correlation appears as only relatively strong policy measures (moving the value for ω to its US level) will bring this correlation down by a meagre 1%. On the other hand, the production-employment correlation drops significantly by 12%.

Table 7: Policy experiments in Germany

Actual omega

Standard deviations

Consumption	0.002
Capital	0.002
Employment	0.010
Production	0.016

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.756	1.000		
Employment	0.596	0.019	1.000	
Production	0.600	-0.048	0.947	1.000

Improvement by 1 std. deviation

Standard deviations

Consumption	0.002
Capital	0.002
Employment	0.010
Production	0.015

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.753	1.000		
Employment	0.602	0.103	1.000	
Production	0.607	-0.038	0.890	1.000

Improvement to UK levels

Standard deviations

Consumption	0.002
Capital	0.002
Employment	0.010
Production	0.015

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.755	1.000		
Employment	0.599	0.099	1.000	
Production	0.604	-0.039	0.890	1.000

Improvement to US levels

Standard deviations

Consumption	0.002
Capital	0.002
Employment	0.010
Production	0.014

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.753	1.000		
Employment	0.592	0.163	1.000	
Production	0.609	-0.031	0.834	1.000

Note: The table shows the calibration results of 5000 simulations when implementing different values for the ω-parameter compared to the benchmark case when ω equals its actual value. Three different policy experiments have been run: ω=0.34, $\omega=\omega^{UK}$ and $\omega=\omega^{US}$. The table reports all standard deviations and correlations irrespective of the statistical significance.

Source: Own calculations

3.2.3 France

The calibration for France presents a completely different picture from the first two country examples. Here, the implementation of already relatively modest changes in the values of ω (one standard deviation) will bring up the volatility measures by 50% for consumption and nearly 85% for employment. The employment-consumption correlation still drops – much as it does in the other cases – but so does the production-consumption correlation making employment and production dependent on each other. The intertemporal smoothing mechanism is therefore not likely to work in this case, even when increasing the value of the ω-parameter beyond the US level. Nevertheless, the increase in volatility is still a sign of an increasing reaction of the main economic variables with respect to shocks, something which may already be of value for macroeconomic policy making.

Part of the reason for the apparent lack of the intertemporal smoothing mechanism to work may be related to incomplete modelling of nominal rigidities. In particular, the significant rise of volatility following a relaxation of quantitative adjustment costs is a clear indication of repressed volatility that would otherwise arise with nominal rigidities. In the current state of the model, however, it is difficult to evaluate whether

the introduction of such nominal rigidities and their reduction implemented in policy experiments would allow to reproduce results similar to those obtained for Spain and Germany.

Table 8: Policy experiments in France

Actual omega

Standard deviations

Consumption	0.004
Capital	0.004
Employment	0.013
Production	0.013

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.606	1.000		
Employment	0.376	0.029	1.000	
Production	0.756	0.143	0.841	1.000

Improvement by 1 std. deviation

Standard deviations

Consumption	0.006
Capital	0.007
Employment	0.024
Production	0.018

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.757	1.000		
Employment	0.308	0.051	1.000	
Production	0.598	0.172	0.914	1.000

Improvement to UK levels

Standard deviations

Consumption	0.009
Capital	0.012
Employment	0.046
Production	0.031

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.894	1.000		
Employment	0.293	0.061	1.000	
Production	0.481	0.193	0.966	1.000

Improvement to US levels

Standard deviations

Consumption	0.010
Capital	0.015
Employment	0.056
Production	0.037

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.917	1.000		
Employment	0.292	0.063	1.000	
Production	0.463	0.197	0.973	1.000

Note: The table shows the calibration results of 5000 simulations when implementing different values for the ω-parameter compared to the benchmark case when ω equals its actual value. Three different policy experiments have been run: ω=0.19, $\omega=\omega^{UK}$ and $\omega=\omega^{US}$. The table reports all standard deviations and correlations irrespective of the statistical significance.

Source: Own calculations

3.2.4 Italy

Similarly to France, the calibration of the Italian policy experiments shows an increase of volatility in the main macroeconomic series, albeit less pronounced than in the French case despite the fact that the original (structural) situation on the labour market as measured by the value of the ω-parameter is quite similar (ω^{Italy}=0.13 compared to ω^{France}=0.10). Part of the reason for the less pronounced increase in volatility may again lay with the (partial) functioning of the intertemporal smoothing mechanism. In Italy, the reduction of the employment-consumption correlation is stronger than in the French case, offsetting partly the (more pronounced) decrease of the production-consumption correlation. Again, similar to France, the lack of accounting for substantial nominal rigidities that may characterise both Italian labour and product markets can be partly held responsible for this result that runs opposite to the policy experiments for Germany and Spain.

Table 9: Policy experiments in Italy

Actual omega

Standard deviations

Consumption	0.005
Capital	0.003
Employment	0.015
Production	0.016

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.239	1.000		
Employment	0.403	-0.114	1.000	
Production	0.811	-0.049	0.845	1.000

Improvement by 1 std. deviation

Standard deviations

Consumption	0.005
Capital	0.003
Employment	0.024
Production	0.020

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.318	1.000		
Employment	0.252	-0.129	1.000	
Production	0.637	-0.071	0.891	1.000

Improvement to UK levels

Standard deviations

Consumption	0.005
Capital	0.005
Employment	0.038
Production	0.028

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.451	1.000		
Employment	0.161	-0.140	1.000	
Production	0.443	-0.089	0.945	1.000

Improvement to US levels

Standard deviations

Consumption	0.005
Capital	0.006
Employment	0.046
Production	0.032

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.514	1.000		
Employment	0.133	-0.141	1.000	
Production	0.377	-0.091	0.958	1.000

Note: The table shows the calibration results of 5000 simulations when implementing different values for the ω-parameter compared to the benchmark case when ω equals its actual value. Three different policy experiments have been run: ω=0.21, $\omega=\omega^{UK}$ and $\omega=\omega^{US}$. The table reports all standard deviations and correlations irrespective of the statistical significance.

Source: Own calculations

Overall, the policy experiments for the four euro area countries do not allow to draw a uniform picture. This can be partly related to the fact that the nature of the imperfections remains relatively limited, not accounting for other rigidities – for instance on the product market, but in particular nominal rigidities – that may be of equal importance in some of these countries. Nevertheless, two results – partly confirmed by an analysis of Japan, see the following box – stand out that are of particular relevance for macroeconomic policies:

- On the one hand, relaxing adjustment costs increases the reaction with respect to shocks, leading to higher volatility of the underlying variables in case of a very rigid economy (in the understanding of this model), in particular when no other mechanism is present that provides risk sharing or allows for flattening of quantitative reactions.
- On the other hand, the reduced correlation between employment and consumption allows for a smoother adjustment path of the economy. For those economies that already are relatively more flexible (again as measured by our model), this allows an overall decrease in the volatility of the

time series as witnessed by the examples of Germany and Spain. The issue of intertemporal smoothing will be further discussed in the following section.

Box: Labour market rigidities and cyclical behaviour – the case of Japan

In order to assess the generality of the methodology developed in the preceding sections, it may be interesting to extend its application to countries outside the euro area. In this respect, the Japanese economy seems to constitute a particular useful example, given its relatively rigid labour market structures, at least when judged from the indicators presented in Table 4.

In table A we presented the match of the calibration of the model to the variances and covariances of the actual data. As can be seen from the table, the standard deviations of the calibrated series match fairly well those of the actual data. However, the calibrated correlations across the main macroeconomic time series provide at best a qualitative assessment regarding the relationships between these variables. However, in particular in comparison with the benchmark perfect competition RBC model (bottom panel) the modified model taking into account the labour market imperfections perform noticeably better.

Table A: Actual and calibrated data for Japan

Actual data

Standard deviations

Consumption	0.011
Capital	0.007
Employment	0.007
Production	0.016

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	-0.108	1.000		
Employment	0.419	-0.318	1.000	
Production	0.881	-0.187	0.576	1.000

Calibrated data

Standard deviations

Consumption	0.011
Capital	0.007
Employment	0.007
Production	0.016

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.411	1.000		
Employment	0.307	-0.017	1.000	
Production	0.692	0.063	0.885	1.000

Calibrated data of standard RBC model

Standard deviations

Consumption	0.009
Capital	0.006
Employment	0.011
Production	0.022

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.404	1.000		
Employment	0.851	-0.129	1.000	
Production	0.952	0.113	0.970	1.000

Note: The standard deviations and correlations for the calibrated data have been calculated on the basis of the actually observed technology shock, not on the simulated one.
Source: Own calculations

Similar to the analysis for the euro area countries, a policy experiment can be conducted for Japan in order to assess how the macroeconomic volatility evolves under the influence of relaxing real labour market rigidities. The results of the exercise are presented in table B. As can be seen from the table, a significant

increase in macroeconomic volatility across all series can be observed, similarly to the results that we had found earlier for France and Italy. At the same time, however, employment shows a significant disconnection from consumption, a phenomenon that we had taken earlier as an indication of increased intertemporal smoothing (see also the discussion in the next section). While this seems to validate our earlier conjecture regarding the importance of labour market deregulation for such risk sharing to be reinforced, it does not – at the same time – lead to a decrease of volatility as we had observed it for Germany and Spain.

Table B: Policy experiments for Japan

Actual omega

Standard deviations

Consumption	0.0125
Capital	0.0094
Employment	0.0436
Production	0.0383

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.3982	1.000		
Employment	0.3044	-0.0293	1.000	
Production	0.6889	0.0499	0.8855	1.000

Improvement by 1 std. deviation

Standard deviations

Consumption	0.0140
Capital	0.0145
Employment	0.0704
Production	0.0537

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.5406	1.000		
Employment	0.2522	-0.0211	1.000	
Production	0.5387	0.0606	0.9402	1.000

Improvement to UK levels

Standard deviations

Consumption	0.0171
Capital	0.0229
Employment	0.1108
Production	0.0795

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.6897	1.000		
Employment	0.2354	-0.0168	1.000	
Production	0.4344	0.0679	0.9706	1.000

Improvement to US levels

Standard deviations

Consumption	0.0192
Capital	0.0283
Employment	0.1348
Production	0.0956

Correlations

	Consumption	Capital	Employment	Production
Consumption	1.000			
Capital	0.7498	1.000		
Employment	0.2335	-0.0147	1.000	
Production	0.4036	0.0720	0.9783	1.000

Note: The standard deviations and correlations have been calculated on the basis of 5000 simulations of technology shock time series.

Source: Own calculations

3.3 Intertemporal smoothing

In order to further test the importance of intertemporal smoothing, the following Table 10 provides an overview of relative volatility of real private consumption with both production and employment series. If the above conjecture is correct, i.e. that a decrease of the consumption-employment correlation is a sign of increasing intertemporal smoothing, the raise in savings should be reflected as a decrease of the relative volatility of consumption with respect to either production or employment or both as it would help to smoothened consumption relative to these two series.

Table 10: Intertemporal smoothing (relative consumption volatility)

Relative Consumption volatility		Employment adjustment costs: ω			
		Actual	+1 std. dev.	UK-level	US-level
DE	with respect to production	10.6%	10.8%	10.8%	10.9%
ES		47.2%	43.9%	44.2%	44.8%
FR		34.6%	30.7%	27.7%	27.2%
IT		28.9%	23.8%	18.2%	16.5%
JP		32.7%	26.1%	21.5%	20.1%
DE	with respect to employment	16.3%	16.4%	16.5%	16.2%
ES		120.0%	103.8%	98.1%	91.2%
FR		32.7%	22.8%	18.5%	18.0%
IT		30.5%	19.9%	13.2%	11.6%
JP		28.7%	19.9%	15.4%	14.3%

Note: The table presents the relative volatility of consumption both with respect to production and employment as a measure of intertemporal smoothing.

Source: Own calculations

In this regard, the following numbers are roughly confirming our initial conjecture in the preceding section. Interestingly to note is that both for France and for Italy, a substantial smoothening of consumption can be observed that has not been reflected in the above correlations. On the other hand, consumption has not increased in relative smoothness in Germany (the differences across the policy experiments are not statistically significant) despite the above observed reduced correlation between consumption and employment.

4. Conclusion

The preceding report has attempted to assess the likely impact of structural reforms on the dynamic properties of euro area countries. In particular a dynamic general (dis-)equilibrium model reflecting (structural) imbalances on the labour market has been developed, whose detailed interaction mechanisms have been discussed here. In the report, it has been argued that these imbalances are particularly important in the case of euro area countries and that besides having lasting long-term effects on macroeconomic performance, they may also impact on the short-run macro-dynamics. After a discussion of the methodology, the report has presented the steps that led to the estimation of structural parameters and calibration results reflecting the dynamic properties of four major euro area economies. Finally, structural reforms on the labour market have been simulated in order to assess their likely impact on the volatility and correlation of the main macroeconomic time series that are calibrated.

On the basis of these calibration results the following conclusions can be drawn:

- Our macroeconomic (dis-)equilibrium model allows to reflect the variation across countries with respect to the employment adjustment costs.
- Moreover, introducing these imperfections on the labour market considerably improves the quality of the calibration in comparison to the actual data. In particular, both the volatility of employment increases and its correlation with consumption decreases.
- Finally, implementing structural reforms by allowing employment adjustment costs to be lower improves the efficiency characteristics of euro area economies. In particular, the correlation between consumption and employment further decreases. The report conjectures that this may be related to improved intertemporal smoothing.

Overall, first evidence is presented regarding the impact of structural reforms on the dynamic properties of euro area economies. Although this evidence is not unambiguous, it shows potentially beneficial effects of structural reforms on labour markets not only for the long-term performance but also for the medium term volatility (which may have an impact on welfare as well). At the current juncture, the model presented in this paper is not detailed enough to allow for a richer picture of structural rigidities in euro area countries. Its conclusions have, therefore, to be taken with some caution; nevertheless, the promising nature of such an approach has been shown for further developments including a more detailed description of the price setting behaviour of firms.

5. References

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6. Data appendix

6.1 Time period covered

The following table summarises the time periods covered for the different OECD countries that have been estimated in this report.

Table 11: Country time periods

code	country	Time period
BE	**Belgium**	*1979Q1-2003Q4*
DE	**Germany**	*1968Q1-2003Q4*
ES	**Spain**	*1977Q1-2000Q4*
FI	**Finland**	*1976Q1-2003Q4*
FR	**France**	*1976Q1-2003Q4*
IE	**Ireland**	*1980Q1-2003Q4*
IT	**Italy**	*1980Q1-2004Q1*
NL	**Netherlands**	*1977Q4-2004Q1*
AT	**Austria**	*1980Q1-2003Q4*
UK	**United Kingdom**	*1972Q1-2004Q1*
SE	**Sweden**	*1968Q1-2003Q4*
NO	**Norway**	*1979Q1-2003Q4*
US	**USA**	*1964Q1-2003Q4*
CA	**Canada**	*1962Q1-2003Q4*
JP	**Japan**	*1970Q1-2003Q4*

Source: OECD, 2004

6.2 Treatment of missing observations

Some of the data have only been available at the annual frequency. In order to obtain quarterly data, the series have been interpolated with quarterly indices of related series. This has been a particular problem for capital stock data that often only exist at an annual frequency. Here, we interpolated using quarterly Gross Fixed Capital Formation data. Similarly some of the capacity utilisation series had to be proxied. The method has made use of the Chow-Lin (1971) approach using GLS estimators to account for serial correlation in the data.

6.3 Country notes

The following tables summarise the country coverage for the individual series and provide – where necessary – remarks regarding the adjustment that had to be undertaken for some of them.

Table 12: Country tables

Belgium

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1978Q1-2004Q1	
Capital stock	1961Q2-2004Q1	
Hours Worked	1971Q1-2004Q1	Quarterly data are repeated annual observations
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

Germany

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	Break in series in 1991Q1
Private Consumption	1960Q1-2004Q1	Break in series in 1991Q1
Gross Fixed Capital Formation	1960Q1-2004Q1	Break in series in 1991Q1
Government Consumption	1960Q1-2004Q1	Break in series in 1991Q1
Exports	1968Q1-2004Q1	Break in series in 1991Q1
Imports	1968Q1-2004Q1	Break in series in 1991Q1
GDP Deflator	1960Q1-2004Q1	Break in series in 1991Q1
Wage rate	1960Q1-2004Q1	Break in series in 1991Q1
Capacity utilisation	1960Q1-2004Q1	Break in series in 1991Q1
Capital stock	1960Q4-2004Q1	Break in series in 1991Q1
Hours Worked	1960Q1-2004Q1	Break in series in 1991Q1
Employment	1960Q1-2004Q1	Break in series in 1991Q1
Labour Force	1960Q1-2004Q1	Break in series in 1991Q1

Note: The break in the series due to the reunification has been accounted for by estimating and calibrating the model for both the period before and after the break separately.

Spain

Variable	*Availability*	*Remarks*
GDP	1977Q1-2003Q4	
Private Consumption	1977Q1-2003Q4	
Gross Fixed Capital Formation	1977Q1-2003Q4	
Government Consumption	1977Q1-2003Q4	
Exports	1977Q1-2003Q4	
Imports	1977Q1-2003Q4	
GDP Deflator	1977Q1-2003Q4	
Wage rate	1977Q1-2003Q4	
Capacity utilisation	1977Q1-2003Q4	
Capital stock	1977Q1-2003Q4	
Hours Worked	1977Q1-2003Q4	Monthly hours; break in series 2000Q1
Employment	1977Q1-2003Q4	
Labour Force	1977Q1-2003Q4	in thousands

Finland

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1966Q1-2003Q4	Constructed from "Firms expecting bottlenecks"; actual capacity utilisation indicator only available from 1993Q1 on.
Capital stock	1975Q4-2004Q1	
Hours Worked	1960Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

France

Variable	*Availability*	*Remarks*
GDP	1963Q1-2004Q1	
Private Consumption	1963Q1-2004Q1	
Gross Fixed Capital Formation	1963Q1-2004Q1	
Government Consumption	1963Q1-2004Q1	
Exports	1963Q1-2004Q1	
Imports	1963Q1-2004Q1	
GDP Deflator	1963Q1-2004Q1	
Wage rate	1960Q1-2003Q4	
Capacity utilisation	1976Q1-2004Q1	
Capital stock	1962Q4-2004Q1	
Hours Worked	1970Q1-2004Q1	
Employment	1960Q1-2003Q4	
Labour Force	1960Q1-2003Q4	

Ireland

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	Adjusted GDP for net exports; Exports>GDP starting in 1999Q4
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2003Q4	
Capacity utilisation	1980Q1-2004Q1	
Capital stock	1960Q4-2004Q1	Only available as index
Hours Worked	1970Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

Italy

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1969Q1-2004Q1	
Capital stock	1960Q4-2004Q1	
Hours Worked	1960Q4-2004Q1	
Employment	1960Q4-2004Q1	
Labour Force	1960Q4-2004Q1	

Netherlands

Variable	*Availability*	*Remarks*
GDP	1977Q1-2004Q1	
Private Consumption	1977Q1-2004Q1	
Gross Fixed Capital Formation	1977Q1-2004Q1	
Government Consumption	1977Q1-2004Q1	
Exports	1977Q1-2004Q1	
Imports	1977Q1-2004Q1	
GDP Deflator	1977Q1-2004Q1	
Wage rate	1977Q1-2004Q1	
Capacity utilisation	1977Q1-2004Q1	
Capital stock	1977Q1-2004Q1	
Hours Worked	1977Q1-2004Q1	
Employment	1977Q1-2004Q1	
Labour Force	1977Q1-2004Q1	

Austria

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1963Q1-2004Q1	Constructed using Orders level, Mfg. Sa.
Capital stock	1960Q1-2004Q1	
Hours Worked	1970Q1-2004Q1	Repeated observations 1970Q1-1979Q4; only annual data available starting 1980Q1
Employment	1965Q1-2004Q1	
Labour Force	1965Q1-2004Q1	

Sweden

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1968Q1-2004Q1	Hourly earnings mining & manufacturing
Capacity utilisation	1960Q1-2004Q1	Constructed using "Orders inflows ten-dency"
Capital stock	1965Q4-2004Q1	
Hours Worked	1960Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

UK

Variable	*Availability*	*Remarks*
GDP	1972Q1-2004Q1	
Private Consumption	1972Q1-2004Q1	
Gross Fixed Capital Formation	1972Q1-2004Q1	
Government Consumption	1972Q1-2004Q1	
Exports	1972Q1-2004Q1	
Imports	1972Q1-2004Q1	
GDP Deflator	1972Q1-2004Q1	
Wage rate	1972Q1-2004Q1	
Capacity utilisation	1972Q1-2004Q1	
Capital stock	1972Q1-2004Q1	
Hours Worked	1972Q1-2004Q1	
Employment	1972Q1-2004Q1	
Labour Force	1972Q1-2004Q1	

Norway

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1973Q4-2004Q1	Index centered around 0: add 80%
Capital stock	1966Q4-2004Q1	
Hours Worked	1962Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

USA

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1964Q1-2004Q1	
Capacity utilisation	1960Q1-2004Q1	
Capital stock	1960Q1-2004Q1	
Hours Worked	1960Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

Canada

Variable	*Availability*	*Remarks*
GDP	1961Q1-2004Q1	
Private Consumption	1961Q1-2004Q1	
Gross Fixed Capital Formation	1961Q1-2004Q1	
Government Consumption	1961Q1-2004Q1	
Exports	1961Q1-2004Q1	
Imports	1961Q1-2004Q1	
GDP Deflator	1961Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1962Q1-2003Q4	
Capital stock	1961Q4-2004Q1	
Hours Worked	1961Q1-2004Q1	
Employment	1961Q4-2004Q1	
Labour Force	1961Q4-2004Q1	

Japan

Variable	*Availability*	*Remarks*
GDP	1960Q1-2004Q1	
Private Consumption	1960Q1-2004Q1	
Gross Fixed Capital Formation	1960Q1-2004Q1	
Government Consumption	1960Q1-2004Q1	
Exports	1960Q1-2004Q1	
Imports	1960Q1-2004Q1	
GDP Deflator	1960Q1-2004Q1	
Wage rate	1960Q1-2004Q1	
Capacity utilisation	1968Q1-2004Q1	Only available as index; multiply with 0.0075 before use
Capital stock	1965Q4-2004Q1	
Hours Worked	1970Q1-2004Q1	
Employment	1960Q1-2004Q1	
Labour Force	1960Q1-2004Q1	

Note: All series for capacity utilisation refer to the manufacturing sector only.