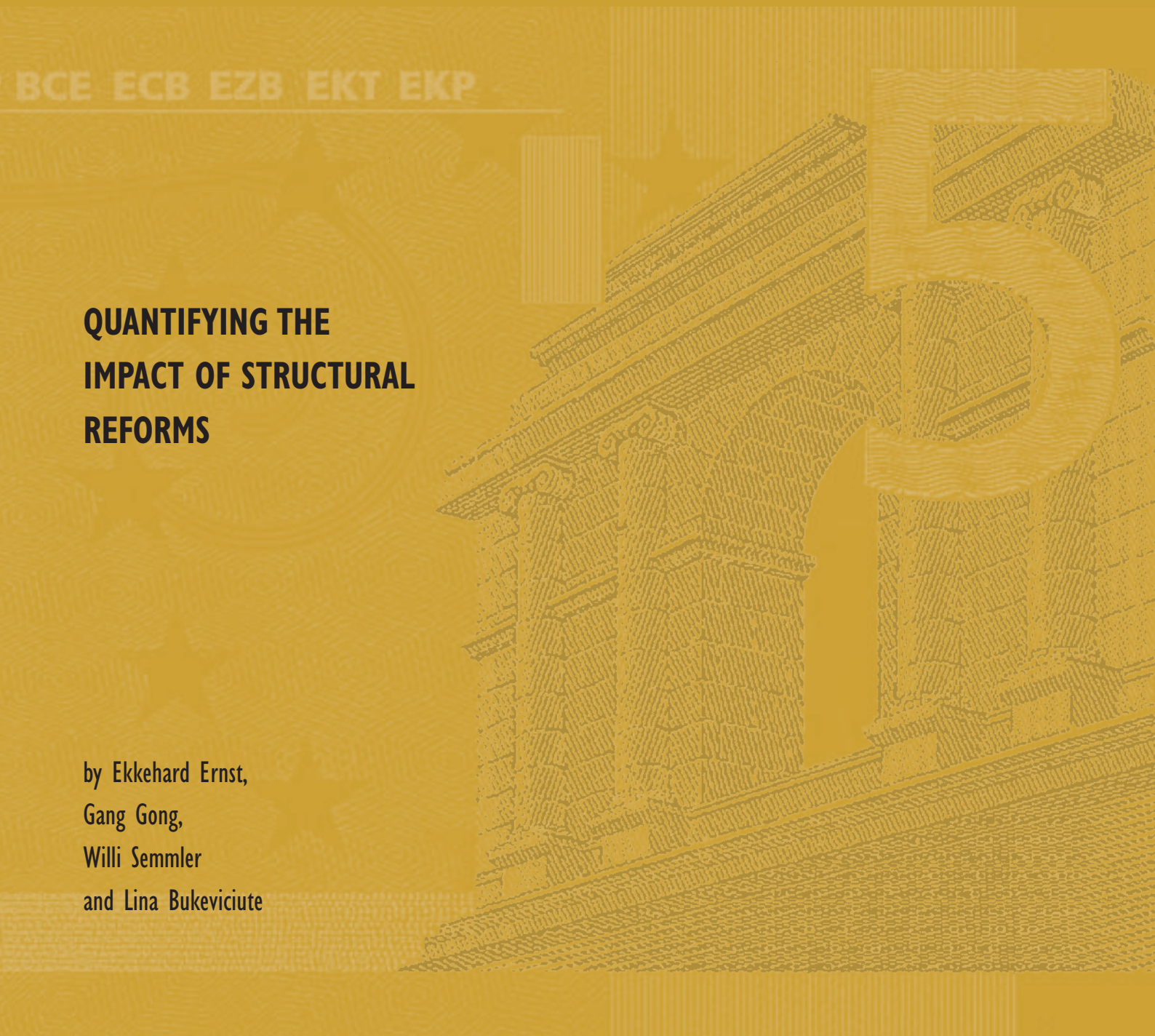
EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO 666 / AUGUST 2006




# QUANTIFYING THE IMPACT OF STRUCTURAL REFORMS

by Ekkehard Ernst,
Gang Gong,
Willi Semmler
and Lina Bukeviciute

EUROPEAN CENTRAL BANK

WORKING PAPER SERIES
NO 666 / AUGUST 2006

# QUANTIFYING THE IMPACT OF STRUCTURAL REFORMS [1]

by Ekkehard Ernst,[2]
Gang Gong,[3]
Willi Semmler[4]
and Lina Bukeviciute[5]


In 2006 all ECB publications will feature a motif taken from the €5 banknote.

This paper can be downloaded without charge from http://www.ecb.int or from the Social Science Research Network electronic library at http://ssrn.com/abstract_id=921080

*1 An earlier draft of this paper had been prepared while Ekkehard Ernst was an economist and Gang Gong a consultant at the European Central Bank, which is thanked for its generous funding of this project. Excellent research assistant has been provided by Michele Lenza. This draft has benefited from helpful comments by Benoît Mojon, participants at an ECB internal presentation and participants of a seminar at the German Bundesbank. We also want to thank Christian Haefke for his comments when the paper was presented at a session of the Econometric Society at the ASSA Conference in Boston, January 6-8, 2006. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or the ECB.*

*2 Corresponding author: OECD, Economics Department, 2, Rue André Pascal, 75775 Paris Cedex 16, France; e-mail: ekkehard.ernst@oecd.org*

*3 School of Economics and Management, Tsinghua University, Beijing 100084, China; e-mail: gongg@em.tsinghua.edu*

*4 New School and SCEPA, New York, and CEM, Bielefeld University. Contacts: The New School for Social Research, 65 Fifth Avenue, New York, NY 10003, USA; e-mail: semmlerw@newschool.edu*

*5 European Central Bank, Kaiserstrasse 29, 60311 Frankfurt am Main, Germany; e-mail: lina.bukeviciute@ecb.int*

**Address**
Kaiserstrasse 29
60311 Frankfurt am Main, Germany

**Postal address**
Postfach 16 03 19
60066 Frankfurt am Main, Germany

**Telephone**
+49 69 1344 0

**Internet**
http://www.ecb.int

**Fax**
+49 69 1344 6000

**Telex**
411 144 ecb d



ISSN 1561-0810 (print)
ISSN 1725-2806 (online)

# CONTENTS

**Abstract**

We estimate a dynamic intertemporal model with non-clearing markets that mimics features of European labour markets, such as sticky nominal wages and sluggish adjustment of employment to shocks for 15 OECD countries. The estimates include a measure for the degree of labour market sluggishness that compares well with standard indicators of product and labour market regulation. Calibration of the model on a selected country sample confirms its explanatory power in comparison with the standard competitive markets model. In a second step, the measure for labour market sluggishness is used as a policy variable and model variants are simulated in order to assess the extent to which the countries would have performed better with more flexible labour markets. These policy experiments show that an increase in labour market flexibility reduces the volatility of consumption relative to production, improves intertemporal efficiency but entails higher employment risk for households.

**JEL Codes:** E32, C61

**Keywords:** nominal and real rigidities, non-clearing labour markets, business cycles, labour market reforms in OECD countries

## Non-technical summary

Structural reforms have been stressed recurrently by international organisations and central banks such as the OECD, the IMF and 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. 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-term dynamics have only recently gained more prominence in economic analysis, mainly through the development of models around the New Keynesian type. However, while these models have been very popular in assessing the impact of monetary (and fiscal) policy in an environment with market imperfections, the correlation and dynamic links that exist between the main macroeconomic aggregates, their interaction with structural rigidities on labour and product markets and the consequences this may have for economic efficiency have not (yet) been widely studied.

In order to address the impact of structural reforms on the short-term macroeconomic performance in a coherent way, we present an intertemporal model with capital accumulation and non-clearing labour and product markets that can account for both nominal and real rigidities. Introducing disequilibrium and nonclearing markets is meant to yield a first approximation to modelling the adjustment problems that the European countries face with their persistent high level of (structural) unemployment, concentrating, however, on the short-run dynamics. By using the disequilibrium approach to labour market frictions, we take an agnostic stance regarding the origin of the underlying nominal or real rigidities. The model's parameters are estimated for 15 different OECD countries. Besides parameters for preferences and technology, the degree of labour market disequilibrium can be numerically assessed and compared with standard institutional indicators regarding structural rigidities on labour and product markets. With these parameter estimates at hand, we first calibrate the model for a selected sample of OECD economies in order to assess its fit in comparison with the Real Business Cycle model of the competitive type. We show that our macroeconomic non-clearing labour market model allows better than the standard RBC model to reflect the existence of labour market institutions and the institutional variation of labour markets across OECD countries. Moreover, introducing nominal and real frictions and non-clearing markets appear to describe the labour market dynamics better than the standard RBC model. In particular, the disequilibrium model allows better to account for well-known problems of the standard RBC model such as the excessive smoothness of employment in comparison with empirical data.

In a second step, we run various alternative simulations with changes in the degree of labour market disequilibrium in order to evaluate the impact a more flexible labour market may have on the dynamic properties of the model. In particular, we look at the volatility of consumption relative to production and employment, as an indirect measure of intertemporal efficiency. In our policy simulations, we show that, while reducing employment protection legislation and hence labour adjustment costs for firms, households are able to improve risk sharing over the cycle and decrease consumption volatility, yet they face higher employment risk. Increasing labour market flexibility thereby improves the efficiency characteristics of these simulated economies by resulting in a greater intertemporal consumption smoothing but it also entails a higher employment risk faced by households.

Overall, the paper presents comparative and consistent evidence on the impact of nominal and real stickiness as well as the structural reforms on the dynamic properties of OECD economies. The model shows some potential to evaluate structural reforms by explicitly estimating frictions on labour and product markets. By carrying out simulations we are able to assess the short-run dynamic properties resulting from these frictions. Reducing them affects both intertemporal efficiency and households' employment risk. An important issue in this context is the problem to what extent households have sufficient access to financial markets, if -- through reforms -- the labour market is made more flexible. To our knowledge, however, this aspect of structural reforms has not sufficiently been addressed in the literature.

# 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 (for important recent studies see Bayouni, Laxton and Pesenti (2004); OECD (2003); Derose, Langedijk and Roeger (2004) and Roeger (2004)). In this paper we will particularly focus on nominal and real rigidities of the labour market and the effect of labour market reforms on the macroeconomic performance of the countries.

As concerning the labour market, it is usually presumed that nominal rigidities constrain the scope and speed of real variables to adjust to aggregate supply or demand shocks. These nominal rigidities are to induce changes in the reaction of nominal prices and wages. Consequently, the adjustment of output and employment may depend on whether nominal rigidities are high (strong pressure on output to adjust) or low (low output adjustment). As compared to nominal rigidities, real rigidities are thought to prevent the economy to move more rapidly to some steady state. Hence, the flexible economy is believed to move in a faster way to some equilibrium by adjusting prices and output more speedily.

A related but somehow different question regards the co-variation and dynamic links that exist between the main macroeconomic aggregates for economies with less or more flexibility. In order to address the impact of structural reforms on the macroeconomic performance in a coherent way, an intertemporal model with non-clearing markets will be used that can account for nominal and real rigidities. Our model with frictions on the labour market is meant to yield a first approximation to modelling the adjustment problems that the European countries face with their persistent high level of (structural) unemployment, concentrating, however, on the short and medium run dynamics. We employ here a model that has been proposed in Gang and Semmler (2006, ch. 8; 2003).[2] The model can be estimated and simulated for different countries and the effect of various policy parameters on the short-and medium run dynamics can be considered.

In order to assess the importance of structural rigidities such as those discussed above and their importance for European economies, we will make use of an intertemporal decision model with price rigidities and disequilibrium on the labour market. The main deviation from the standard perfect competition, market

[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] Our model has strong similarities with a recent model by Uhlig (2004). There, however, exogenous wages are presumed, while for our paper a sequence of (sticky) wages has been taken from the data.

clearing model, underlying the usual RBC model, is here that in our model transactions can take place off the equilibrium path. For the product market, 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.

The remainder of this paper is organized as follows. Section 2 presents the structure of our dynamic non-clearing market model, estimates it for selected OECD countries and explores the role of nominal and real stickiness. Section 3 studies the possible impacts of structural reforms in the context of such a model by undertaking simulations. Section 4 concludes the paper.

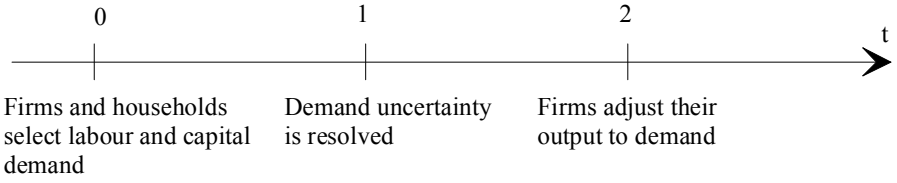
## 2. Model set up and estimations

In the following, we will describe the main structure 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[3]

The underlying macroeconomic model follows closely established standards in the literature. In particular, it is based on an intertemporal decision model with a representative household that determines its consumption and leisure pattern with respect to a budget constraint and an accumulated capital stock. The economy is subject to a continuous stream of technology shocks, which are supposed to be the only source of shocks. Two model variants will be analysed, one being the standard model of market clearing, and 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. The timing of the decision problem is shown in figure 1.

**Figure 1: The timing of market exchanges**




[3] This section builds on the paper by Gong and Semmler (2003) and Gang and Semmler (2006, Ch. 8). A similar model can be found in Uhlig (2004) where wages are also modelled as very sticky, not adjusting smoothly to the intertemporal choice of the economic agents.

### 2.1.1 The model structure

To take a short cut, we can presume, as the equilibrium model does, that 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.

At period $t=0$, 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

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

where superscripts $d$ and $s$ stand for "demand" and "supply", $\beta$ designates the intertemporal preference rate, $\delta$ the depreciation rate, $\pi$ firms' profits and $\gamma$ 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 period $t=0$, 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[4].

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, 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 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:

$$n_t = \omega n_t^d + (1-\omega) n_t^s, \tag{A1.3}$$

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[5] 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 $\left(k_t, n_t\right)$

4 This may nevertheless happen if either the representative firm has perfect foresight on the sequence of technology shocks or the wage contract is done in the form of a contingency plan. Both will be excluded here; see Gong and Semmler (2003) on a discussion on this latter point. In an extension of our model we presume that the wage is partially adjusted to some optimal wage, ω*, but it is still very sticky, see Gong and Semmler (2005). There we also get a non-clearing labour market.

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

implicitly given by the above output supply function equation, this new optimal planning program writes as:

$$\max_{c_t^d} E\left[U\left(c_t^d, n_t\right) + \sum_{i=1}^{\infty} \beta^i U\left(c_{t+i}^d, n_{t+i}^s\right)\right] \tag{A1.4}$$

subject to

$$k_{t+1}^s = \frac{1}{1+\gamma}\left[(1-\delta)k_t^s + f\left(k_t, n_t, A_i\right) - c_t^d\right]$$

$$k_{t+i+1}^s = \frac{1}{1+\gamma}\left[(1-\delta)k_{t+i}^s + f\left(k_{t+i}^s, n_{t+i}^s, A_{t+i}\right) - c_{t+i}^d\right], \quad i = 1,2,\ldots$$

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*.

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

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

The stationarity parameter, $\gamma$, 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 and model estimation**

The estimation of the model is based on the data generation process that 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

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

- 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

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

The model is estimated by minimising the weighted distance between observed and simulated values of *k*, *c* and *n* where the weighting matrix suggested by Newey and West (1987) has been used.

## 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[6]. Concretely, the

[6] 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).

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; this is achieved through a minimum distance estimator between the observed data and those produced by the data generation process (see the box above). Notice, moreover, that these parameters can be established without a concrete knowledge of the underlying labour market disequilibrium as they are supposed to be fundamental to preferences and technology and hence unrelated to rigidities on the labour market[7].

Given the highly non-linear nature of the optimisation problem, the algorithm used to pick the right parameters $\beta$, $\delta$ and $\theta$ 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 uses Monte Carlo techniques to search for a global optimum.[8] 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[9]. As can be seen from the table, the parameters β, δ, θ and α for each of those countries fall into the vicinity of parameters that have been utilized in calibration exercises of RBC models or have been estimated for certain country specific data sets.[10]

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[11]. 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 fall into a reasonable range. Yet, it must be mentioned that no commonly accepted estimates exist regarding the substitution elasticity between consumption and leisure. In calibration studies it is usually assumed that a reasonable range of the elasticity of substitution parameter is $0.5<\theta<4$; our estimates for this parameter fall into the range $1.5<\theta<4$, and are thus quite reasonable.

---

7 Using the same fundamental parameters for both the competitive RBC model and the disequilibrium model puts further restrictions on the latter: Assessing the fit of the disequilibrium model and its improvement over the RBC is hence related exclusively to the introduction of the disequilibrium process itself, which is what we want to concentrate on in this paper.

8 Details of this algorithm are described in Gong and Semmler (1997) and Judd (1998, ch. 8.3, pp. 299-301). In the absence of a closed-form solution for the standard errors of the parameters, no standard errors have been reported as we are primarily interested by consistent estimates, not necessarily efficient ones (similar to the majority of papers in this vein). The representative agent framework being only a very rough approximation to reality, the standard errors of these parameters have to be expected to be large as neither agent heterogeneity nor capital vintages are taken into account. We take, however, comfort in the fact that our estimates of the country-specific deep parameters are close to those reported in the literature.

9 See section 5.1 for the different country-specific time periods.

10 Estimations for different US data sets are reported in Gong and Semmler (2006, Ch. 5). There an also be found a detailed discussion of estimation strategies.

11 Note that the depreciation rates correspond to quarterly values.

**Table 1: Structural parameters**

| country | $\beta$ | $\delta$ | $\theta$ | $\alpha$ |
|---|---|---|---|---|
| **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 | 2.6869 | 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 ($\beta$), the depreciation rate of capital ($\delta$); the substitution elasticity between consumption and leisure ($\theta$) and the substitution elasticity between capital and labour ($\alpha$).

Source: Own calculations, OECD (2004)

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.

## 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. Note that our estimation strategy implies that the short side is not effective but rather our compromise rule. This means that one is neither on the demand nor on the supply curve of labour. By positing that the compromise rule holds we postulate that labour market institutions (such as employment protection, wage bargaining coordination and union density as discussed below) determine the degree of real rigidities in the labour market. This is measured by the ω in equation (A1.3). This means the higher the ω the more the labour demand (from the side of firms) will be the dominant side and vice versa.

Since, our parameter ω 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 detail in the following paragraph. Let us describe here first 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 notational 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 minimizing the residual square sum of the difference between actually observed employment and model-generated employment. In formal terms:

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

were $n$ comes from the frictionless model and $n^d$, $n^s$ result from the model where the households' and firms' decisions have been taken under constraints.

The results of this estimation procedure and the resulting ω-parameters are reported in Table 2 including both euro area and non-euro area OECD countries. For further reference, the table also reports values of the institutional indicator we have used (such as 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 are at the lower end of the OECD sample with an (unweighted) average value of 18.7% (and a standard deviation of 8.4% ) as compared to an average valued 25.0% (and 9.9% as standard deviation) 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). Thus, as our estimates show countries with higher labour market flexibility exhibits higher ω and vice versa.

**Table 2: 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)

The next question then will be of how these estimations of the labour market adjustment process are affected by structural reforms. 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.

## 2.4 Interpreting Omega: Real or nominal rigidities?

The estimation of the model so far has provided for a first picture on the varieties of labour markets both within the euro area and among OECD countries. Our main parameter by which structural variety is captured is ω. However, when trying to predict the change of our estimated parameters resulting from particular reforms, the theoretical model may give only very scarce information. This is also true 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, at first no clear prediction may be 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 more accurately 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:

- Bargaining coordination and nominal wage rigidity: The labour market disequilibrium process may be determined by nominal wage rigidities. While no immediate good measure of the determinants of nominal wage rigidity may be available[12], 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 as relative wage adjustments between jobs and occupations will be less determined by market forces. A negative correlation with ω would be expected.
- Employment protection and labour adjustment: 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. A negative correlation with ω would be expected.
- Bargaining power: Employment is determined by labour demand the stronger bargaining power of firms in the wage setting process is. Conversely, the estimate of ω would be inversely correlated with the unionisation rate and union density of an economy;
- Speed of entry and exits of firms: 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 negatively correlated with product market regulation since product market regulation may provide more job security.

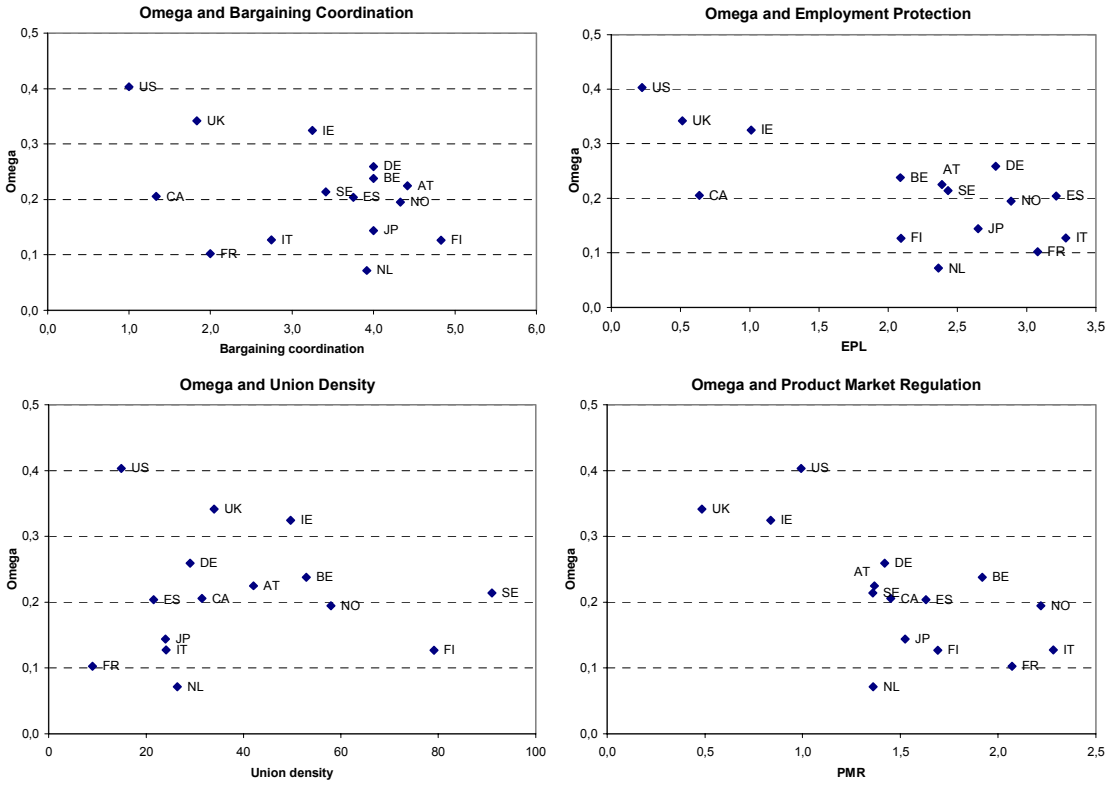
In order to assess which of these four elements best reflects our measure of the labour market disequilibrium process, four indicators have been taken from OECD studies that are widely used and cited in the literature. In particular, we have compared the cross-country variation of our ω-estimates with (i) the degree of wage bargaining coordination, (ii) the strictness of employment protection legislation, (iii) the union density, and (iv) the degree of product market regulation (see Figure 2).

Although, the figure 1 suggest some confirmation of our above predicted correlation with the ω OLS regression reveal that only employment protection and product market regulation provide significant (negative) correlations with our estimated values of the ω-parameter, vindicating the interpretation of ω

[12] See the International Wage Flexibility Network for an example of comparable nominal and real wage rigidity measures, see also Erceg et al. (2000) and Rabanal and Rubio-Ramirez (2005).

measuring quantitative adjustment costs on the labour market[13]. 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.

**Figure 2: 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, in particular, warranted from the point of view of the correlation of ω with employment protection and product market regulation and this will help focusing the discussion in the following sections.

[13] 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.

# 3. Structural reforms and cyclical behaviour

Making labour and product markets more flexible, structural reforms are likely to affect both short-run and long run dynamics and 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[14]. In particular, less connected employment and consumption decisions improve the household's consumption smoothing, with potentially beneficial effects on the aggregate economy.

In this section, we attempt to evaluate these two effects of structural reforms in the context of our model. This will be achieved by replacing the country-specific value of the ω-parameter with different – higher – values and generating artificial macroeconomic time series on the basis of this modified ω-parameter: so called policy experiments that reflect a reduction of real labour market rigidities following structural reforms. Comparing standard deviations and correlation of the (artificial) economy after the structural reform has been implemented with the original estimates allow to assess the importance of changes in adjustment speed for macroeconomic volatility and cyclical efficiency.

Before proceeding with these structural reform experiments, however, we will first assess the extent to which the model allows to replicate the first and second moments of the actual data through a calibration exercise on the country sample that we will use for the policy analysis.

## 3.1 Calibration

Based on the above estimates of the structural parameters, our macroeconomic model can be calibrated to determine to what extent it replicates the time series properties of the underlying sample economy. As it is unlikely that different economies are characterised by exactly the same type of frictions, the calibration is done for several euro area countries to assess differences in the validation of the model depending on the underlying economy.

The quality of the calibration is judged by the degree to which the statistical properties of the calibrated series – i.e. its first and second order moments – match those of the actual time series. However, given that current dynamic general equilibrium models rarely match entirely the underlying sample economy, the following country calibrations should also be judged in comparison with existing approaches in order to

[14] 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.

evaluate to what extent the model described in this note accounts for a particular economic relationship that helps to account for certain economic correlations. In particular, the literature identifies a certain number of limitations of numerical evidence provided by the standard RBC approach (see Cooley, 1995 for an overview) that may be better addressed by a framework departing from the underlying assumption of perfect competition on all markets.

The following Table 3 reports on the standard deviation and correlations of the actual economy and the calibrated sample for four main macroeconomic variables: consumption, the capital stock, employment and production. The model shows differential degrees of success to replicate the moments of the countries' underlying actual data. While the calibration for Spain seems to be rather successful in replicating the sample moments, those for Italy achieve only relative poor results. Overall, the model does not provide exact point estimates of the first and second order moments of the underlying time series but makes up for a qualitatively accurate picture, which can be considered an important improvement with respect to earlier models and which is sufficient from the point of view of our policy analysis in the next section.

The sample of calibrations can be used to draw some overall conclusions regarding the volatility and variable correlations that the model produces. In particular, the following relationships can be established making use of a cross-country comparison of the calibration results:

- Regarding the relative volatility of the different items, the following ranking can be set up: Employment is roughly as volatile as consumption except for Spain, which underwent a convergence process. Consumption is slightly less volatile than production, while capital is the least volatile component
- As regards the cross-variable correlations, the following picture emerges: Production shows the highest correlation with consumption, followed by employment and capital (different ordering for France), while employment is more strongly correlated with production than with consumption. No clear picture emerges regarding the correlation of capital with either employment or production.

Overall, the qualitative performance of our model gives some comfort regarding the underlying transmission mechanisms of economic shocks. While the quantitative mismatch for some countries indicates further missing elements that have to be taken up in a follow-up to this note, the current state of the calibration allows for some policy experiments regarding the change in structural reforms aiming at reducing quantitative restrictions such as employment protection legislation or market entry barriers.

## Table 3: Calibration results for selected countries

### FRANCE

**Actual data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.006 |
| Capital | 0.003 |
| Employment | 0.007 |
| Production | 0.009 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.278 | 1.000 | | |
| Employment | 0.199 | 0.051 | 1.000 | |
| Production | 0.841 | 0.168 | 0.515 | 1.000 |

**Calibrated data**

*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 |

**Competitive model**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.005 |
| Capital | 0.004 |
| Employment | 0.005 |
| Production | 0.009 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.661 | 1.000 | | |
| Employment | 0.742 | -0.013 | 1.000 | |
| Production | 0.821 | 0.364 | 0.769 | 1.000 |

### ITALY

**Actual data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.009 |
| Capital | 0.003 |
| Employment | 0.007 |
| Production | 0.012 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.308 | 1.000 | | |
| Employment | 0.356 | 0.421 | 1.000 | |
| Production | 0.946 | 0.318 | 0.437 | 1.000 |

**Calibrated data**

*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 |

**Competitive model**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.005 |
| Capital | 0.002 |
| Employment | 0.007 |
| Production | 0.014 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.168 | 1.000 | | |
| Employment | 0.955 | -0.126 | 1.000 | |
| Production | 0.981 | -0.024 | 0.995 | 1.000 |

### SPAIN

**Actual data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.011 |
| Capital | 0.006 |
| Employment | 0.024 |
| Production | 0.016 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.620 | 1.000 | | |
| Employment | 0.719 | 0.094 | 1.000 | |
| Production | 0.822 | 0.088 | 0.919 | 1.000 |

**Calibrated data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.002 |
| Capital | 0.002 |
| Employment | 0.003 |
| Production | 0.005 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.628 | 1.000 | | |
| Employment | 0.733 | 0.021 | 1.000 | |
| Production | 0.817 | 0.079 | 0.961 | 1.000 |

**Competitive model**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.002 |
| Capital | 0.002 |
| Employment | 0.003 |
| Production | 0.005 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.560 | 1.000 | | |
| Employment | 0.759 | -0.107 | 1.000 | |
| Production | 0.857 | 0.060 | 0.986 | 1.000 |

### GERMANY

**Actual data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.008 |
| Capital | 0.011 |
| Employment | 0.006 |
| Production | 0.011 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.338 | 1.000 | | |
| Employment | 0.576 | 0.167 | 1.000 | |
| Production | 0.895 | 0.300 | 0.741 | 1.000 |

**Calibrated data**

*Standard deviations*

| | |
|---|---|
| Consumption | 0.002 |
| Capital | 0.003 |
| Employment | 0.013 |
| Production | 0.015 |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | 0.900 | 1.000 | | |
| Employment | 0.638 | 0.385 | 1.000 | |
| Production | 0.752 | 0.407 | 0.893 | 1.000 |

**Competitive model**

*Standard deviations*

| | |
|---|---|
| Consumption | |
| Capital | |
| Employment | |
| Production | |

*Correlations*

| | Consumption | Capital | Employment | Production |
|---|---|---|---|---|
| Consumption | 1.000 | | | |
| Capital | | 1.000 | | |
| Employment | | | 1.000 | |
| Production | | | | 1.000 |

Note: The table shows the comparison of the first and second-order moments of the actual time series with those of the calibration resulting from 5000 simulations. The table reports standard deviations and correlations of the calibrated data irrespective of the statistical significance.

Source: Own calculations

## 3.2 Labour market reforms in euro area countries

Having assessed the fit of the disequilibrium model and its improvement over the competitive RBC model, we will now turn to the labour market policy experiments and discuss their impact 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 Changes in volatility

Reducing labour market rigidities by increasing the ω-parameter value does not yield unambiguous results in our country sample regarding the volatility of the four macroeconomic series under consideration. As a first approximation, it increases the volatility of employment, although this is not vindicated by the reaction of the German employment series, which may, however, be an outlier in any case due to the short length of its series (only the period after reunification has been used for the calibration of the model). Nevertheless, the rise in employment volatility in Spain, France and Italy does not yield the same results as consumption and production volatility decreases in Spain but increases in France and Italy.

Moreover, quantitatively the reaction of the French and Italian series diverge considerably with increasing the ω-parameter despite the fact that the original (structural) situation on the labour market as measured by the value of the ω-parameter is quite similar in the two countries ($\omega^{Italy}$=0.13 compared to $\omega^{France}$=0.10). Qualitatively, however, the volatility reaction of employment and production is in both countries more important than that of the consumption series. This is also true – albeit in an opposite direction – for Spain while Germany experiences reductions in volatility for all four macroeconomic series.

| | | Actual omega | Improvement by 1 std. deviation | Improvement to UK levels | Improvement to US levels |
|---|---|---|---|---|---|
| Germany | Consumption | 1.65 | 1.60 | 1.60 | 1.57 |
| | Capital | 2.41 | 2.36 | 2.37 | 2.34 |
| | Employment | 10.13 | 9.74 | 9.73 | 9.71 |
| | Production | 15.64 | 14.86 | 14.86 | 14.39 |
| Spain | Consumption | 6.00 | 5.40 | 5.30 | 5.20 |
| | Capital | 3.00 | 3.20 | 3.20 | 3.10 |
| | Employment | 5.00 | 5.20 | 5.40 | 5.70 |
| | Production | 12.70 | 12.30 | 12.00 | 11.60 |
| France | Consumption | 4.39 | 5.50 | 8.60 | 10.10 |
| | Capital | 4.17 | 6.50 | 12.10 | 14.70 |
| | Employment | 13.44 | 24.10 | 46.40 | 56.00 |
| | Production | 12.70 | 17.90 | 31.10 | 37.20 |
| Italy | Consumption | 4.62 | 4.74 | 5.08 | 5.32 |
| | Capital | 2.56 | 3.39 | 5.00 | 5.84 |
| | Employment | 15.14 | 23.85 | 38.41 | 45.67 |
| | Production | 15.98 | 19.87 | 27.91 | 32.25 |

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: $\omega=\omega^{country}+0.09$, $\omega=\omega^{UK}$ and $\omega=\omega^{US}$. The table reports all standard deviations and correlations irrespective of the statistical significance.

Source: Own calculations

### 3.2.2 Macroeconomic correlations

At least as important as the volatility reaction is the reaction of the correlations of macroeconomic variables with respect to the changes in labour market rigidities. Phase differences of macroeconomic variables allow households to hedge risk by diversifying their supply decisions (savings and labour supply) across different activities in the economy. The correlations of these variables hence measure to what extent such a risk diversification is possible and are a potential indicator of the welfare loss of labour market rigidities due to the cyclical impact these rigidities have (households are risk averse in our set-up).

In this regard, a noticeable drop in the consumption-employment correlation occurs for our country sample – with the exception of Germany, which may be due to the nature and length of the data, but where the production-employment correlation drops significantly by 12%. This indicates that households are better able to hedge against employment risk when the rigidities on the labour market are reduced, although they have to face higher employment volatility.

Although households seem to be better able to cope with employment risk when labour market rigidities are lower, this may not necessarily be the case for income risk, which is related to the correlation between consumption and production. Both for Germany and Spain, this correlation barely changes with the policy experiments despite the fact that – at least for Spain – both the consumption-employment correlation and the employment-production correlation drop considerably. On the other hand, both in France and Italy, households manage to better cope with the employment and income risk when labour market rigidities are decreasing, as indicated by their reduction in correlation of consumption with both series.

Part of the reason for the apparent lack of the intertemporal smoothing mechanism with respect to income in Germany and Spain may be related to incomplete modelling of nominal rigidities. In particular, the absence of any significant reaction of employment volatility in Germany following a relaxation of quantitative adjustment costs is an indication for additional constraints – both nominally and real – on employment to adjust (such as – for instance – nominal wage floors due to collective wage bargaining). 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 4: Policy experiments and macroeconomic correlations

| | | Germany | | | | Spain | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Consumption | Capital | Employment | Production | Consumption | Capital | Employment | Production |
| **Actual omega** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.756 | 1.000 | | | 0.300 | 1.000 | | |
| | Employment | 0.596 | 0.019 | 1.000 | | 0.828 | 0.061 | 1.000 | |
| | Production | 0.600 | -0.048 | 0.947 | 1.000 | 0.965 | 0.074 | 0.909 | 1.000 |
| **Improvement by 1 std. deviation** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.753 | 1.000 | | | 0.274 | 1.000 | | |
| | Employment | 0.602 | 0.103 | 1.000 | | 0.703 | 0.153 | 1.000 | |
| | Production | 0.607 | -0.038 | 0.890 | 1.000 | 0.964 | 0.075 | 0.808 | 1.000 |
| **Improvement to UK level** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.755 | 1.000 | | | 0.255 | 1.000 | | |
| | Employment | 0.599 | 0.099 | 1.000 | | 0.594 | 0.212 | 1.000 | |
| | Production | 0.604 | -0.039 | 0.890 | 1.000 | 0.962 | 0.075 | 0.725 | 1.000 |
| **Improvement to US level** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.753 | 1.000 | | | 0.224 | 1.000 | | |
| | Employment | 0.592 | 0.163 | 1.000 | | 0.450 | 0.271 | 1.000 | |
| | Production | 0.609 | -0.031 | 0.834 | 1.000 | 0.957 | 0.071 | 0.620 | 1.000 |
| | | **France** | | | | **Italy** | | | |
| | | Consumption | Capital | Employment | Production | Consumption | Capital | Employment | Production |
| **Actual omega** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.606 | 1.000 | | | 0.239 | 1.000 | | |
| | Employment | 0.376 | 0.029 | 1.000 | | 0.403 | -0.114 | 1.000 | |
| | Production | 0.756 | 0.143 | 0.841 | 1.000 | 0.811 | -0.049 | 0.845 | 1.000 |
| **Improvement by 1 std. deviation** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.757 | 1.000 | | | 0.318 | 1.000 | | |
| | Employment | 0.308 | 0.051 | 1.000 | | 0.252 | -0.129 | 1.000 | |
| | Production | 0.598 | 0.172 | 0.914 | 1.000 | 0.637 | -0.071 | 0.891 | 1.000 |
| **Improvement to UK level** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.894 | 1.000 | | | 0.451 | 1.000 | | |
| | Employment | 0.293 | 0.061 | 1.000 | | 0.161 | -0.140 | 1.000 | |
| | Production | 0.481 | 0.193 | 0.966 | 1.000 | 0.443 | -0.089 | 0.945 | 1.000 |
| **Improvement to US level** | Consumption | 1.000 | | | | 1.000 | | | |
| | Capital | 0.917 | 1.000 | | | 0.514 | 1.000 | | |
| | Employment | 0.292 | 0.063 | 1.000 | | 0.133 | -0.141 | 1.000 | |
| | Production | 0.463 | 0.197 | 0.973 | 1.000 | 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: $\omega=\omega^{country}+0.09$, $\omega=\omega^{UK}$ 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 2.

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 5 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 entails an 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 5: 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.

In order for households to be able to insure against certain types of employment and income risks, savings, employment and finance decisions must be at their free disposal; the existence of rigidities and adjustment costs through different institutional settings limits the household's ability for such risk arbitrage, even though it may reduce first-order employment risk. An important issue in this context is the problem to what extent households have sufficiently access to financial markets to smooth out consumption, if -- through reforms -- the labour market is made more flexible. To our knowledge, however, this aspect of structural reforms has not sufficiently been addressed in the literature.

Overall we can observe an increase in intertemporal consumption smoothing is accompanied by a rising ω. Yet, in order to achieve this increased intertemporal smoothing households have to improve on intertemporally arbitraging risk arising from macroeconomic (systemic) risks. What is interesting in this respect in our model here, is that the policy experiments have been conducted on basis of labour market adjustment processes only, unrelated to financial markets (which, anyway, are complete in the model here.) Reduced employment adjustment costs may increasingly privatise production risks in the hands of households. On the other hand, the improved risk insurance that a change in employment adjustment costs implies, results unambiguously in an improvement in the relative dynamics of the different macroeconomic

aggregates that accompanies households smoother consumption path across time, and implying therefore a reduced overall volatility of the consumption path. Less positively formulated, a privatisation of employment risks occurs where households are forced to insure individually against employment risks. In the model here, this is nevertheless beneficial as it decreases both overall production and consumption risk; with a CRRA utility function, this will decrease the risk premium the household is requiring to smooth consumption over the cycle and thereby improve its welfare. The lower employment adjustment costs allow the household to better use the both savings and labour supply decisions to arbitrage production risks, which is made possible by the presence of complete capital markets in our model.

# 4. Conclusion

The paper has attempted to assess the role of labour market institutions, giving rise to labour market frictions and non-clearing markets on the dynamic properties of OECD countries. In particular, we employ a dynamic general (dis-)equilibrium model allowing for both households' decisions of labour supply and consumption paths. Moreover, a model of sticky wages[15] and an adaptive decision process of the households is assumed when solving the model. The household has to take into account constraints on the labour market when the decision over consumption goods is made and firms are possibly constrained on the product market. We have then estimated the labour market disequilibrium parameter ω for a selected group of countries. The paper has presented the steps that led to the estimation of structural parameters and calibration results reflecting the dynamic properties of some OECD economies. We have shown that those ω-parameters are negatively correlated with the labour market institution variables. We have argued that these institutional variables are particularly important in the case of some European OECD countries and that besides having lasting long-term effects on macroeconomic performance, they may also impact on the short-run macro-dynamics. Finally, we have attempted to explore the effects of structural reforms on the labor market for a selection of countries by way of simulations 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 simulation results the paper allows to draw some conclusions:

- Our macroeconomic non-clearing labour market model allows better than the standard RBC model to reflect the existence of labour market institutions and the institutional variation of labour markets across OECD countries.
- Moreover, introducing nominal and real frictions and non-clearing market appear to describe the labour market dynamics better than the standard RBC model. In particular, the behaviour of the

[15] A Calvo type wage adjustment with strong wage persistence is discussed in Gong and Semmler (2005).

macro variables significantly become more realistic as compared to standard intertemporal model with frictionless choice of labour effort and consumption.

- Finally, we could study the effects of implementing structural reforms by allowing the nominal and real frictions to be reduced which, on the one hand, increases the production and employment risks in the hands of households. On the other hand, it improves the efficiency characteristics of OECD economies by resulting in a greater intertemporal consumption smoothing.[16]

Overall, the paper presents first evidence on the impact of nominal and real stickiness as well as the structural reforms on the dynamic properties of OECD economies. The model shows some potential to evaluate structural reforms. At the current juncture, the model presented in this paper may still not be detailed enough to allow for a richer picture of nominal and real stickiness in OECD countries. Its conclusions have, therefore, to be taken with some caution; nevertheless, the paper shows the promising nature of such an approach for further developments including a more detailed description of the price setting behaviour of firms and the nature of capital markets.

[16] Which, in order to properly work, requires perfect capital markets.

## References


[1.] Allen, F. and D. Gale (2000), Comparing Financial Systems, MIT Press, Cambridge/MA;

[2.] Bayoumi, T., D. Laxton and P. Pesenti (2004), "Benefits and spillovers of greater competition in Europe: A macroeconomic assessment", CEPR Discussion Paper, no. 4481;

[3.] Benassy, J.-P. (2002), The Macroeconomics of Imperfect Competition and Nonclearing Markets, MIT-Press, Cambridge/MA.;

[4.] Blanchard, O. and J. Wolfers (2000), "The Role of Shocks and Institutions in the Rise of European Unemployment: The Aggregate Evidence", Economic Journal, 110, pp. C1-C33;

[5.] Burnside, C., M. Eichenbaum and S. Rebelo (1993), "Labor hoarding and the business cycle", Journal of Political Economy, 101, pp. 245-273;

[6.] Burnside, C., M. Eichenbaum and S. Rebelo (1995), "Capital Utilization and Returns to Scale", NBER Working Papers, no. 5125;

[7.] Caballero, R. J. and M. Hammour (1998), "The Macroeconomics of Specificity", Journal of Political Economy, 39/2, pp. 257-273;

[8.] Campbell, J. (1994), "Inspecting the mechanism", Journal of Monetary Economics, 33, pp. 463-506;

[9.] Chow, G. and A.-L. Lin (1971), "Best Linear Unbiased Interpolation, Distribution, and Extrapolation of Time Series by Related Series", Review of Economics and Statistics, 53/4, pp. 372-375;

[10.] Cooley, T. (1995), "Calibrated models", Oxford Review of Economic Policy, 13/3, pp. 55-69;

[11.] Danthine, J.-P. (1997), "In Search of a Successor to IS-LM", Oxford Review of Economic Policy, 13/3, pp. 135-144;

[12.] Derose, S., S. Langedijk and W. Roeger (2004), "Reviewing adjustment dynamics in EMU: from overheating to overcooling", European Economy, Economic Papers, no. 198;

[13.] ECB (2004), "Labour productivity developments in the euro area: Aggregate trends and sectoral patterns", Monthly Bulletin, July, pp. 47-57;

[14.] Erceg, C., D. Henderson and A. Levin (2001), "Optimal monetary policy with staggered wage and price contracts", Journal of Monetary Economics, 46, pp. 281-313;

[15.] Flaschel, P., G. Gong and W. Semmler (2001),"A Keynesian Macroeconometric Framework for the Analysis of Monetary Policy Rules", Journal of Economic Behaviour and Organisation, 46, pp.101-136;

[16.] Francis, N. and V. Ramey (2003), "Is the Technology-Driven Real Business Cycle Hypothesis Dead? Shocks and Aggregate Fluctuations Revisited", UCSD, mimeo;

[17.] Frisch, R. (1933), "Propagation and impulse problems in dynamic economics", in: Economic Essays in Honor of Gustav Cassel, pp. 171-205;

[18.] Gali, J. (1999), "Technology, Employment, and the Business Cycle: Do Technology Shocks Explain Aggregate Fluctuations?", American Economic Review, 89, pp. 249-271;

[19.] Gong, G. and W. Semmler (1997), "A Numerical Procedure to Estimate Real Business Cycle Models Using Simulated Annealing", in: Computational Approaches to Economic Problems, ed. By H. Amman,B. Rustem and A. Whinston, Kluwer Academic Publishers.

[20.] Gong, G. and W. Semmler (2003), "Business Cycles, Wage Stickiness and Nonclearing Labor Market", University of Bielefeld, Center for Empirical Macroeconomics Working Paper no. 53;

[21.] Gong, G. and W. Semmler (2005), "Sticky Wages and Nonclearing Labour Market in Business Cycles", working paper, http://NewSchool.edu/gf/CEM

[22.] Gong, G. and W. Semmler (2006), "Stochastic Dynamic Macroeconomics – Theory and Empirical Evidence", New York, Oxford University Press.

[23.] Hall, R. E. (1986) "Market Structures and Macroeconomic Fluctuations", Brookings Papers on Economic Activity, Vol. 2, (1986), pp. 285-322;

[24.] Heckman, J. (2001), "Flexibility and Creation: Job Lessons from the German Experience", in: P. Aghion, R. Frydman, J. Stiglitz and M. Woodford (eds.), Knowledge, Information, and Expectations in Modern Macroeconomics, Princeton University Press , Princeton, pp. 357-393;

[25.] Judd, Kenneth (1998), Numerical Methods in Economics, MIT Press, Cambridge/MA;

[26.] King, R. G. and S. T. Rebelo (2000), "Resuscitating real business cycles", NBER Working Paper, no. 7534;

[27.] Kydland, F. and E. Prescott (1982), "Time to build and aggregate fluctuations", Econometrica, 50, pp. 1345-1370;

[28.] Ljungqvist, L. and T. J. Sargent (1998), "The European Unemployment Dilemma", Journal of Political Economy, 106/3, pp. 514-550;

[29.] Long, J. B. and C. I. Plosser (1983), "Real Business Cycles", Journal of Political Economy, 91, pp. 39-69;

[30.] Mátyás, L. (ed.) (1999), Generalized Method of Moments Estimation, Cambridge University Press;

[31.] Merz, M. (1995), "Search in the labor market and the real business cycle", Journal of Monetary Economics, 36, pp. 269-300;

[32.] Meyers, R.J. (1964), "What can we learn from European Experience, in Unemployment and the American Economy?", ed. by A. M. Ross, New York;

[33.] Newey, W.K. and K.D. West (1987), "A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix", Econometrica, 55, pp. 195-232;

[34.] Nickell, S. (1997), "Unemployment and labor market rigidities – Europe versus North America", Journal of Economic Perspectives, 3, pp. 55-74;

[35.] OECD (1998), International Regulation Database, Paris;

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

[37.] OECD (2004), Economic Outlook Database, no. 75;

[38.] Oliveira Martins, J. and S. Scarpetta (1999), "The levels and cyclical behaviour of mark-ups across countries and market structures", OECD Economics Department, Working Paper, no. 213;

[39.] Phelps, E. and G. Zoega (1997), "The Rise and Downward Trend of the Natural Rate", American Economic Association Papers and Proceedings, 87/2, pp. 283-289;

[40.] Prescott, E. (1986), "Theory ahead of business-cycle measurement", Federal Reserve Bank of Minneapolis Quarterly Review, 10, pp. 9-22;

[41.] Ramey, G. and J. Watson (1997), "Contractual Fragility, Job Destruction, and Business Cycles", Quarterly Journal of Economics, 112, pp. 873-911;

[42.] Slutsky, E. (1937) , "The summation of random causes as the source of cyclic processes", Econometrica, 5/2, pp. 105-146;

[43.] Uhlig, H. (2004), "Macroeconomics and asset markets: some mutual implications", Humboldt University, mimeo

[44.] Woodford, M. (2003), Interest and Prices: Foundations of a Theory of Monetary Policy, Princeton University Press, Princeton

# 5. Data appendix

## 5.1 Time period covered

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

**Table 6: 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

## 5.2 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.

## 5.3 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 7: 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.

**European Central Bank Working Paper Series**

For a complete list of Working Papers published by the ECB, please visit the ECB's website (http://www.ecb.int)

617 "New survey evidence on the pricing behaviour of Luxembourg firms" by P. Lünnemann and T. Y. Mathä, May 2006.

618 "The patterns and determinants of price setting in the Belgian industry" by D. Cornille and M. Dossche, May 2006.

619 "Cyclical inflation divergence and different labor market institutions in the EMU" by A. Campolmi and E. Faia, May 2006.

620 "Does fiscal policy matter for the trade account? A panel cointegration study" by K. Funke and C. Nickel, May 2006.

621 "Assessing predetermined expectations in the standard sticky-price model: a Bayesian approach" by P. Welz, May 2006.

622 "Short-term forecasts of euro area real GDP growth: an assessment of real-time performance based on vintage data" by M. Diron, May 2006.

623 "Human capital, the structure of production, and growth" by A. Ciccone and E. Papaioannou, May 2006.

624 "Foreign reserves management subject to a policy objective" by J. Coche, M. Koivu, K. Nyholm and V. Poikonen, May 2006.

625 "Sectoral explanations of employment in Europe: the role of services" by A. D'Agostino, R. Serafini and M. Ward-Warmedinger, May 2006.

626 "Financial integration, international portfolio choice and the European Monetary Union" by R. A. De Santis and B. Gérard, May 2006.

627 "Euro area banking sector integration: using hierarchical cluster analysis techniques" by C. Kok Sørensen, J. M. Puigvert Gutiérrez, May 2006.

628 "Long-run money demand in the new EU Member States with exchange rate effects" by C. Dreger, H.-E. Reimers and B. Roffia, May 2006.

629 "A market microstructure analysis of foreign exchange intervention" by P. Vitale, May 2006.

630 "Implications of monetary union for catching-up member states" by M. Sánchez, May 2006.

631 "Which news moves the euro area bond market?" by M. Andersson, L. J. Hansen and S. Sebestyén, May 2006.

632 "Does information help recovering structural shocks from past observations?" by D. Giannone and L. Reichlin, May 2006.

633 "Nowcasting GDP and inflation: the real-time informational content of macroeconomic data releases" by D. Giannone, L. Reichlin and D. H. Small, May 2006.

634 "Expenditure reform in industrialised countries: a case study approach" by S. Hauptmeier, M. Heipertz and L. Schuknecht, May 2006.

635 "Identifying the role of labor markets for monetary policy in an estimated DSGE model" by K. Christoffel, K. Kuester and T. Linzert, June 2006.

636 "Exchange rate stabilization in developed and underdeveloped capital markets" by V. Chmelarova and G. Schnabl, June 2006.

637 "Transparency, expectations, and forecasts" by A. Bauer, R. Eisenbeis, D. Waggoner and T. Zha, June 2006.

638 "Detecting and predicting forecast breakdowns" by R. Giacomini and B. Rossi, June 2006.

639 "Optimal monetary policy with uncertainty about financial frictions" by R. Moessner, June 2006.

640 "Employment stickiness in small manufacturing firms" by P. Vermeulen, June 2006.

641 "A factor risk model with reference returns for the US dollar and Japanese yen bond markets" by C. Bernadell, J. Coche and K. Nyholm, June 2006.

642 "Financing constraints and firms' cash policy in the euro area" by R. Pál and A. Ferrando, June 2006.

643 "Inflation forecast-based-rules and indeterminacy: a puzzle and a resolution" by P. Levine, P. McAdam and J. Pearlman, June 2006.

644 "Adaptive learning, persistence, and optimal monetary policy" by V. Gaspar, F. Smets and D. Vestin, June 2006.

645 "Are internet prices sticky?" by P. Lünnemann and L. Wintr, June 2006.

646 "The Dutch block of the ESCB multi-country model" by E. Angelini, F. Boissay and M. Ciccarelli, June 2006.

647 "The economic effects of exogenous fiscal shocks in Spain: a SVAR approach" by F. de Castro Fernández and P. Hernández de Cos, June 2006.

648 "Firm-specific production factors in a DSGE model with Taylor price setting" by G. de Walque, F. Smets and R. Wouters, June 2006.

649 "Monetary and fiscal policy interactions in a New Keynesian model with capital accumulation and non-Ricardian consumers" by C. Leith and L. von Thadden, June 2006.

650 "A structural break in the effects of Japanese foreign exchange intervention on yen/dollar exchange rate volatility" by E. Hillebrand and G. Schnabl, June 2006.

651 "On the determinants of external imbalances and net international portfolio flows: a global perspective" by R. A. De Santis and M. Lührmann, July 2006.

652 "Consumer price adjustment under the microscope: Germany in a period of low inflation" by J. Hoffmann and J.-R. Kurz-Kim, July 2006.

653 "Acquisition versus greenfield: the impact of the mode of foreign bank entry on information and bank lending rates" by S. Claeys and C. Hainz, July 2006.

654 "The German block of the ESCB multi-country model" by I. Vetlov and T. Warmedinger, July 2006.

655 "Fiscal and monetary policy in the enlarged European Union" by S. Pogorelec, July 2006.

656 "Public debt and long-term interest rates: the case of Germany, Italy and the USA" by P. Paesani, R. Strauch and M. Kremer, July 2006.

657 "The impact of ECB monetary policy decisions and communication on the yield curve" by C. Brand, D. Buncic and J. Turunen, July 2006.

658 "The response of firms' investment and financing to adverse cash flow shocks: the role of bank relationships" by C. Fuss and P. Vermeulen, July 2006.

659 "Monetary policy rules in the pre-EMU era: Is there a common rule?" by M. Eleftheriou, D. Gerdesmeier and B. Roffia, July 2006.

660 "The Italian block of the ESCB multi-country model" by E. Angelini, A. D'Agostino and P. McAdam, July 2006.

661 "Fiscal policy in a monetary economy with capital and finite lifetime" by B. Annicchiarico, N. Giammarioli and A. Piergallini, July 2006.

662 "Cross-border bank contagion in Europe" by R. Gropp, M. Lo Duca and J. Vesala, July 2006.

663 "Monetary conservatism and fiscal policy" by K. Adam and R. M. Billi, July 2006.

664 "Fiscal convergence before entering the EMU" by L. Onorante, July 2006.

665 "The euro as invoicing currency in international trade" by A. Kamps, August 2006.

666 "Quantifying the impact of structural reforms" by E. Ernst, G. Gong, W. Semmler and L. Bukeviciute, August 2006.

ISSN 1561081-0